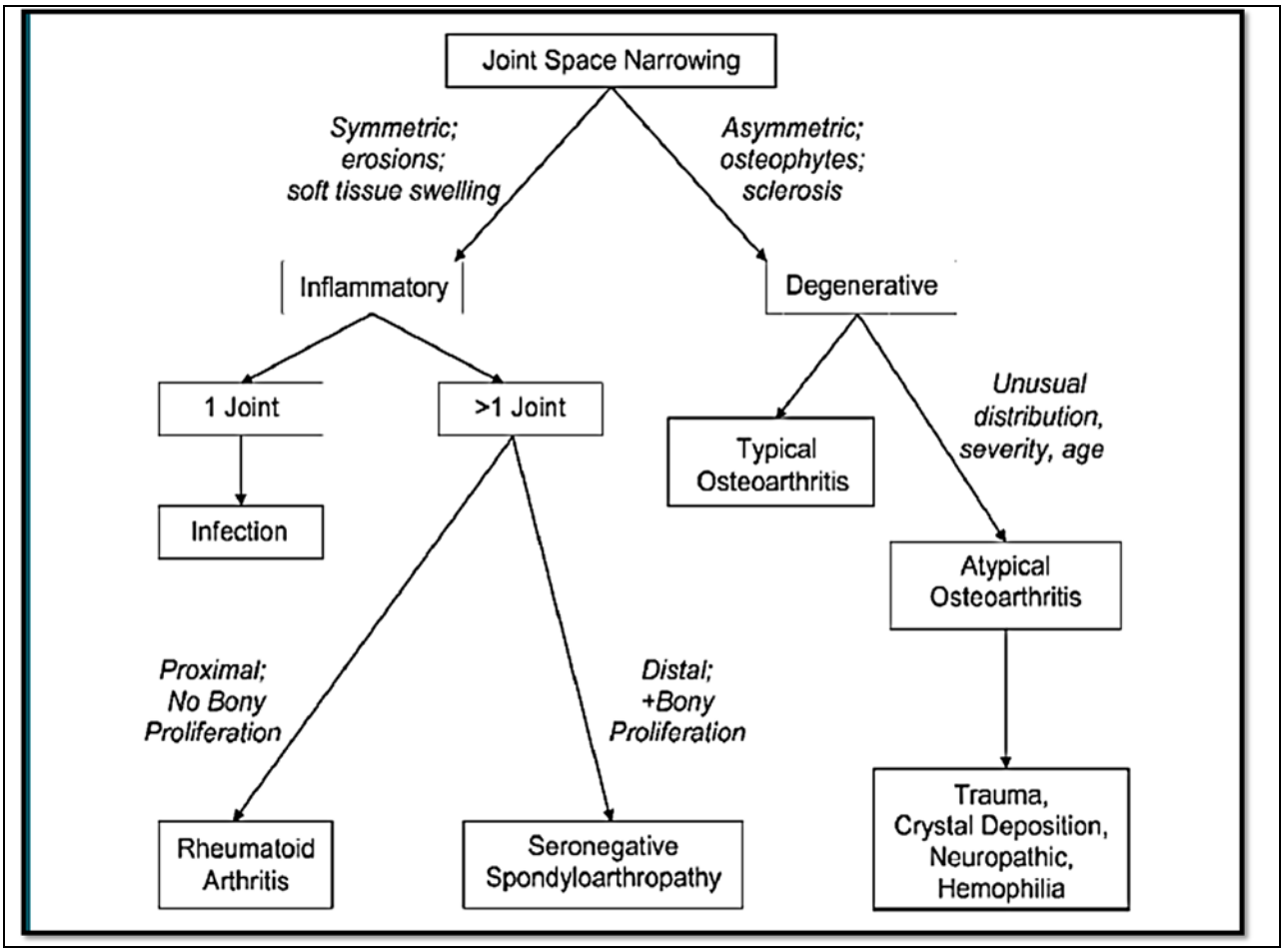
MUSCULOSKELETAL IMAGING

ARTHRITIS

Compiled by:

Dr. M. Samy, MD

Algorithm for Arthritis ☺



I- Inflammatory Arthritis

Erosive Arthritis

A) <u>Autoimmune Arthritis</u>

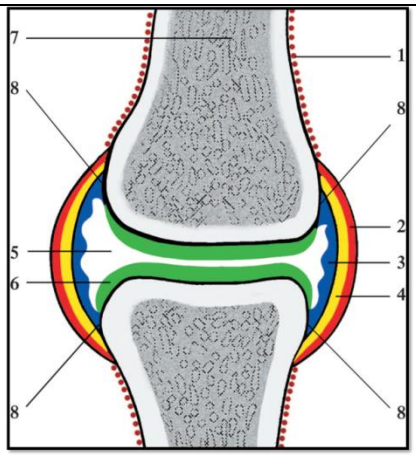
1) **RA**
2) **Scleroderma**
3) **SLE**
4) **Dermatomyositis**

B) <u>Seronegative Spondyloarthropathies = Mixed Erosive + Sclerotic</u>

1) **Ankylosing spondylitis**
2) **Psoraisis**
3) **Reiter's syndrome**
4) **Enteropathic arthropathy**
5) **Undeferrentiated Spondyloarthritis**

C) <u>Erosive Osteoarthritis.</u>

Schematic drawing of a synovial joint.
1 = periosteum
2 = outer fibrous layer of the capsule
3 = internal synovial layer of the capsule
4 = fat and loose soft tissue
5 = articular space
6 = cartilage
7 = bone
8 = bare area.



A) Autoimmune Arthritis

1) Rheumatoid Arthritis

- Most common inflammatory arthritis
- 1% of the global adult population
- F > M = 2 – 3 times
- Age = 4th - 6th decades of life.
- Most common sites: Hands, wrists, and feet

Etiology => Multifactorial:

- Genetic susceptibility: HLA-DR4 (70% of patients)
- Environmental factors: smoking
- Infectious agents

ACR 1987 Revised Criteria for the Classification of Rheumatoid Arthritis

Criterion	Description
Morning stiffness	Morning stiffness in and around the joints that lasts at least 1 hour before maximal improvement
Arthritis in three or more areas	At least three joint areas that simultaneously have soft-tissue swelling or fluid (not bone overgrowth alone) observed by a physician (the 14 possible joint areas are the right and left PIP, MCP, wrist, elbow, knee, ankle, and MTP joints)
Arthritis of hand joints	At least one of the following joint areas is swollen: wrist, MCP, or PIP joint (see description of second criterion)
Symmetric arthritis	Simultaneous involvement of the same joint areas listed for the second criterion on both sides of the body (bilateral involvement of PIP, MCP, or MTP joints is acceptable without absolute symmetry)
Rheumatoid nodules	Subcutaneous nodules over bone prominences or extensor surfaces or in juxtaarticular regions observed by a physician
Serum rheumatoid factor	Demonstration of abnormal amounts of serum rheumatoid factor with any method that has yielded positive results in <5% of healthy control subjects
Radiographic changes	Changes typical of rheumatoid arthritis on posteroanterior radiographs of the hand and wrist; these must include erosions or unequivocal bone decalcification localized to or most marked adjacent to the involved joints (osteoarthritic changes alone do not qualify)

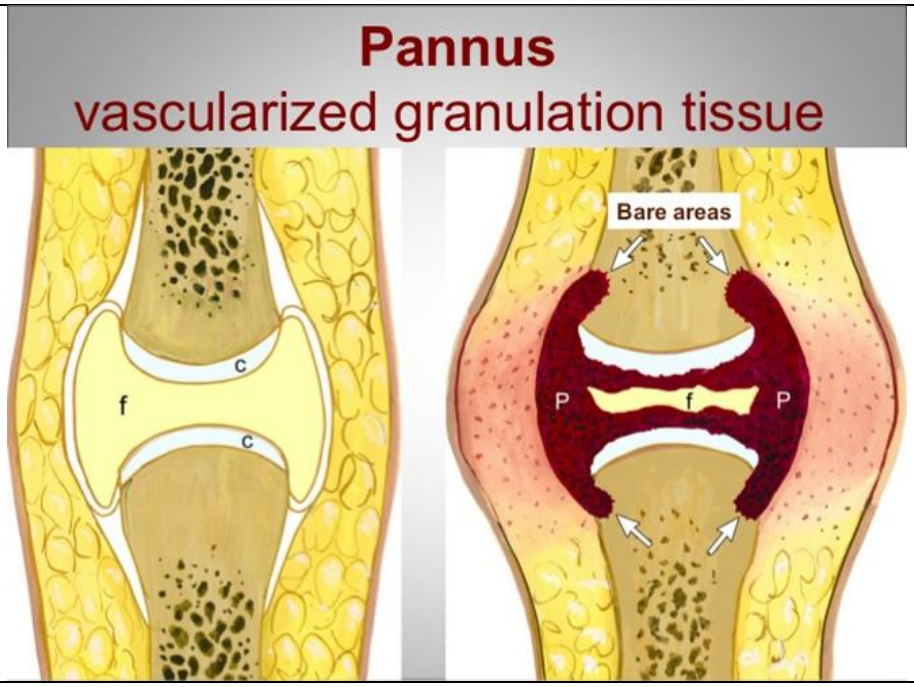
Patho-physiology:

Autoimmune => Synovium => inflammatory process (Cytokines)

- ⇨ Synovial thickening + proliferation + infiltration => Pannus formation
- ⇨ Invades & erodes Bare area = The bone is covered by synovium only; between the insertion of the fibrous capsule and the cartilage)
- ⇨ Invades & erodes Cartilage => Narrowing of joint space
- ⇨ Invades & erodes Subchondral bone => Subchondral synovial cyst
- ⇨ Progressive fibrosis => Fibrous Ankylosis

Important Para- and Extraarticular Findings in RA

Location	Findings	Comments
Tendons	Synovitis of tendon sheaths, tendinitis, tendon rupture	The extensor carpi ulnaris, flexor carpi ulnaris, flexor carpi radialis, and extensor carpi radialis are frequently involved
Bursae	Synovitis, erosions of abutting bone	The retrocalcaneal, olecranon, and subacromial bursae are frequent sites of involvement
Subcutaneous	Rheumatoid nodules*	Calcification is an unusual feature; rheumatoid nodules may ulcerate, drain, and give rise to an infection
Bones	Osteopenia, bone fracture, avascular osteonecrosis	. . .
Systemic†	Vasculitis, myopathy, cardiovascular disease‡	RA may manifest as a systemic disease with anemia, lymphadenopathy, hepatosplenomegaly, iridocyclitis, leg ulcers, myopericarditis, serositis, leukocytosis, rheumatic rash, and fever

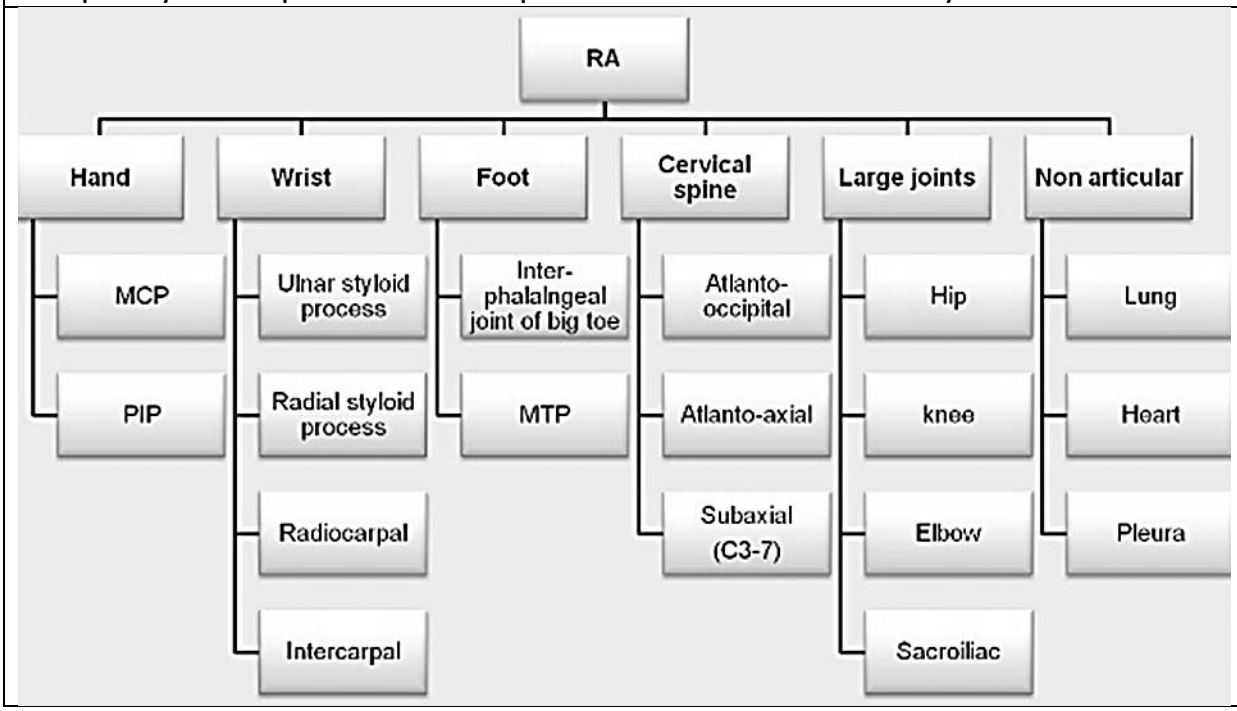


Distribution

- Polyarticular > 3 joints
- Bilateral & symmetrical arthritis
- Hand: MCP and PIP joints
    - 2^{nd} & 3^{rd} MCP (radial aspect > ulnar aspect)
- Foot: MTP and PIP joints
    - 4^{th} & 5^{th} MTP
- Wrist:
    - Ulnar styloid process.
    - Triquetrum.
    - Radiocarpal joint and intercarpal carpometacarpal joints.
    - Sparing DIP

Pattern

- Erosive + NO proliferative changes helps in the distinction from seronegative spondylarthropathies such as psoriatic arthritis or Reiter syndrome.



Role of MRI:

- Establish an early diagnosis of rheumatoid arthritis.
- Identify inflammation at the insertions of ligaments and tendons (enthesitis) that help differentiate rheumatoid arthritis from some clinical subsets of peripheral spondyloarthropathies.

MR Imaging Findings of Early Rheumatoid Arthritis:

- Joint space => Synovitis (Pannus) + Effusion + Narrowing
- Bone Marrow => Periarticular BM edema (Hyperemia) + Subchondral cysts + Erosions
- Tendons => Tenosynovitis + Tendinosis

Synovitis:

- T1 WI: Intermediate - low SI
- T2 WI: High SI
- STIR: more clearly delineates disease extent
- Very heavily T2 WI: can be helpful in identifying synovitis, which has a lower SI than does joint effusion.
- Contrast-enhanced T1 WI:
- Early phase: Acute synovitis enhance rapidly and intensely
- Delayed phase: Joint fluid enhancement occurs after > 10 min, reaches a plateau after 30 minutes, and persists for at least 1 hour; may be related to the diffusion of gadolinium into the synovial joint fluid.

Pannus

- T2/STIR: Synovial proliferation can be seen as hypointense frondlike material outlined by high-signal-intensity joint fluid.

Synovial Fluid:

T2/STIR: Hyperintesne signal
+C: NO enhancement.

Rice bodies

- Small fragments of the hypertrophic synovium may undergo fibrinoid necrosis and slough into the joint.

Tenosynovitis:

- T2/SIR: Increased fluid signal around the tendon
- +C: Abnormal enhancement.

Bone marrow edema;

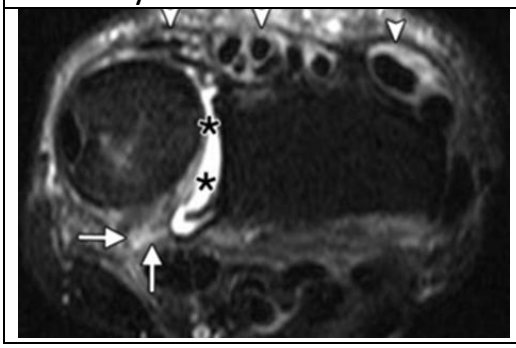
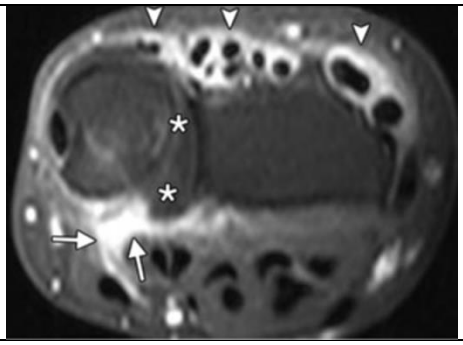
- Ill defined area, Low T1, High T2

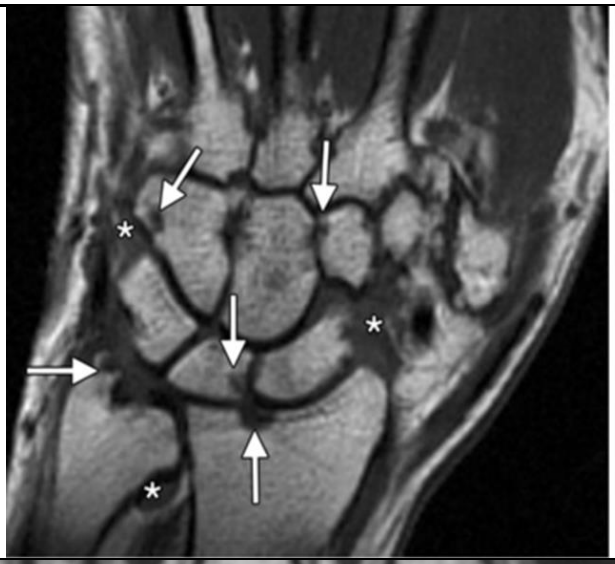
❖ Early MRI findings in RA

Synovitis + BM edema

Coronal T1: Low SI	Coronal STIR High SI	Coronal T1+C+FS Enhancement

Synovitis VS Joint effusion

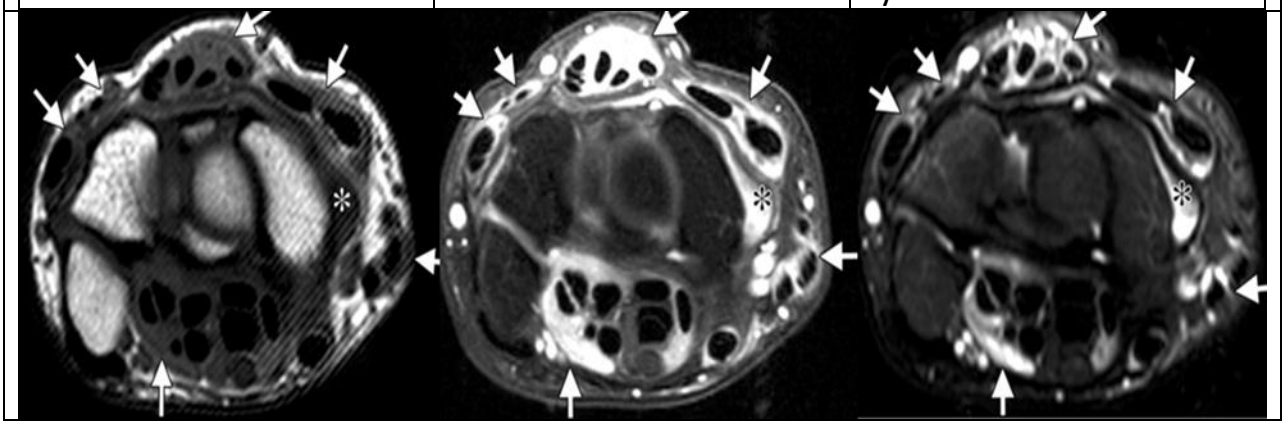
Heavily T2 FS:	**T1+C FS:**
Joint effusion signal >> Acute Synovitis	Acute Synovitis => enhance Joint effusion => No enhancement
	

Synovitis (*) + Erosions (arrow)	
Enhancement of synovium is useful in differentiating from joint effusion	
Enhancement of erosions implies the presence of inflamed synovium within the defect and is useful in differentiating them from fluid-filled simple and degenerative cysts	
Coronal T1	**Coronal T1+C FS**
	

Tenosynovitis

- Tenosynovitis is commonly seen in early RA of the wrists and hands.
- Synovial tissue of tendon sheaths is naturally involved in RA.
- Extensor carpi ulnaris is a typical and early site of RA manifestations at the wrist.
- The inflammatory process may well lead to erosions of the styloid process of the ulna in the course of the disease.

T1: Intermediate signal (arrows)	STIR: high fluid in the tendon sheath, increased thickness	T1+C FS contrast enhancement of the tendon sheath synovium



❖ Radiographic Findings

- Periarticular fusiform soft tissue swelling
- Periarticular osteopenia
- Marginal erosions
- Diffuse joint space narrowing.
- Joint deformity

i. Periarticular fusiform soft-tissue swelling

- Periarticular soft tissue edema
- Joint effusion
- Tenosynovitis

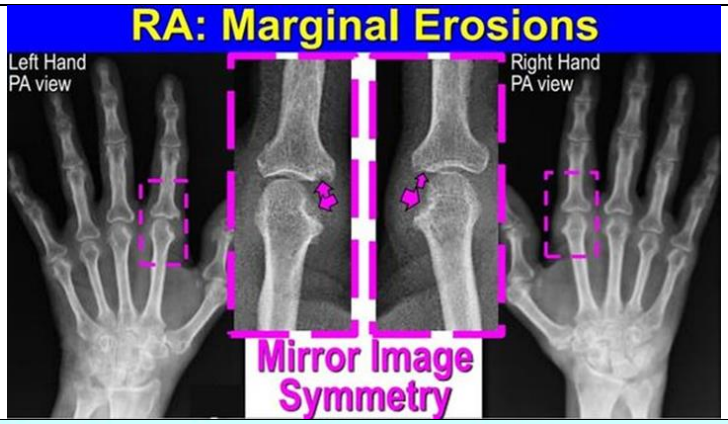
ii. Juxtaarticular Osteopenia

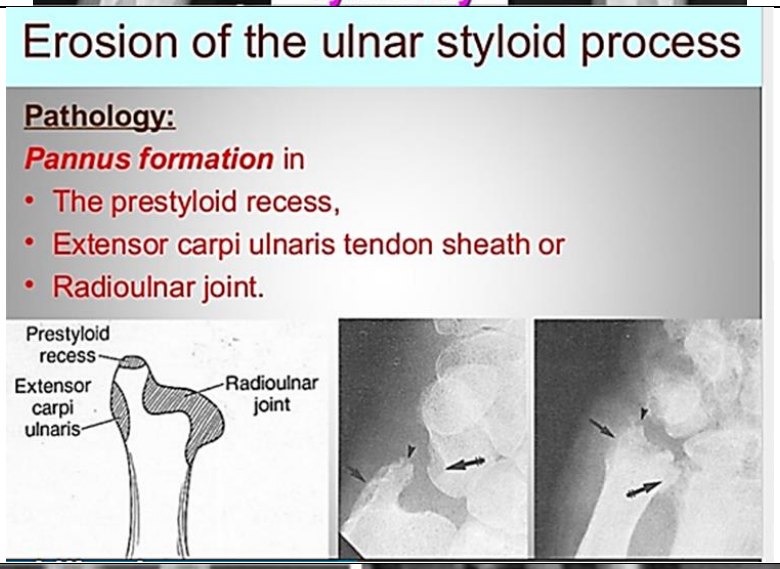
Hyperemia at the articulating bones

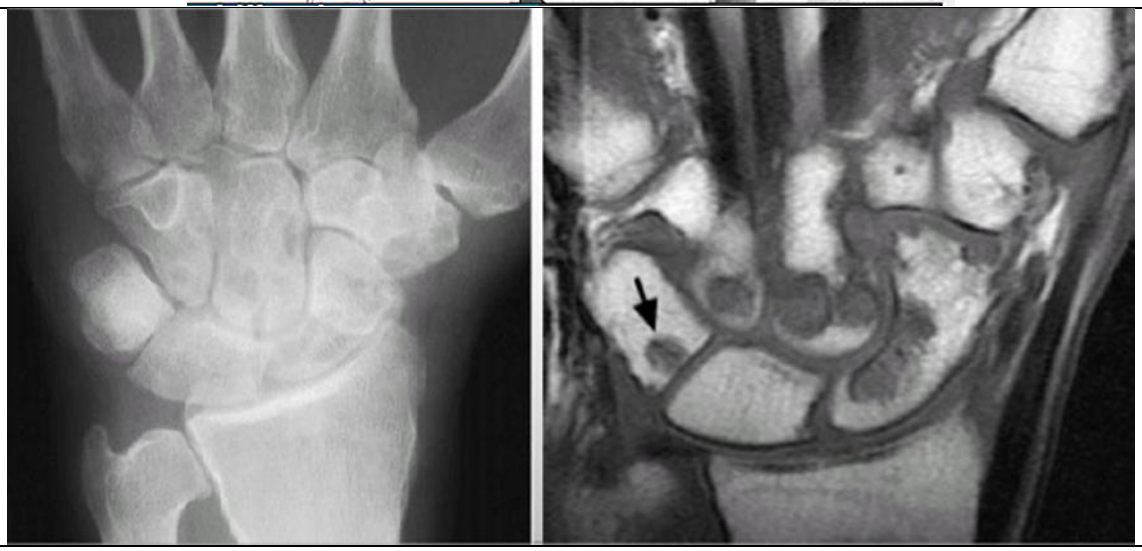
iii. Narrowing of joint spaces

RA => concentric narrowing
OA => eccentric narrowing.

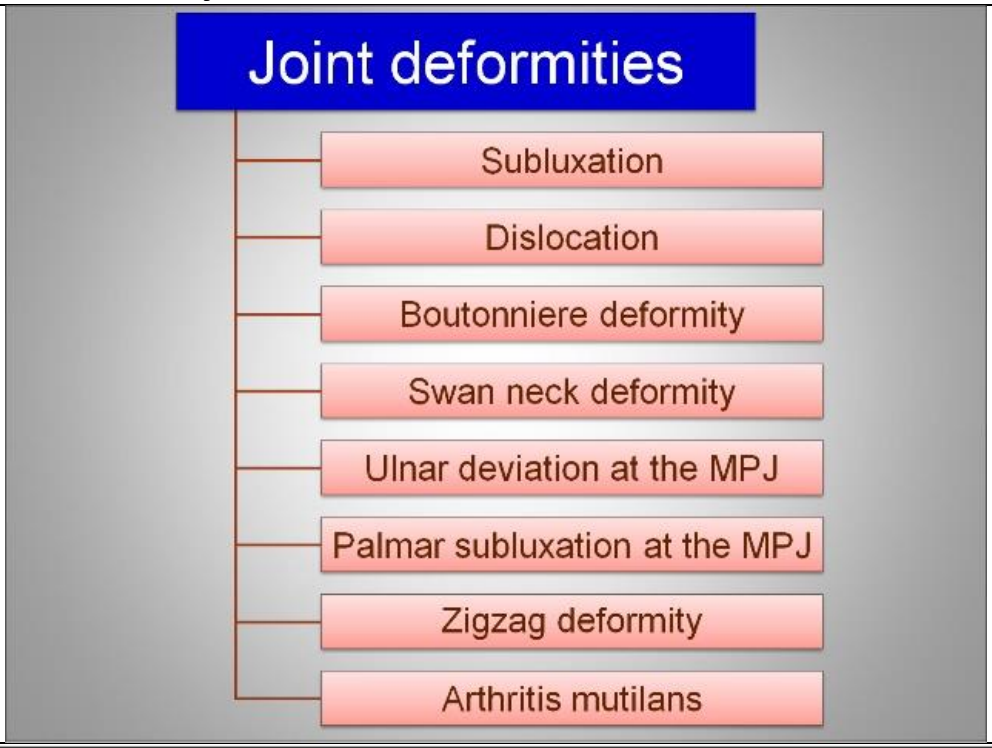
iv. Marginal Erosions







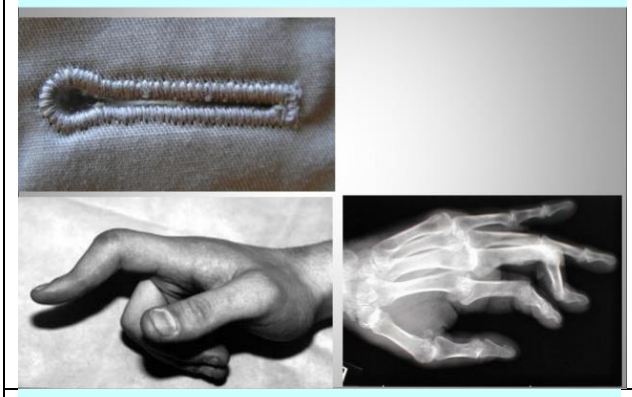
v. Joint Deformity



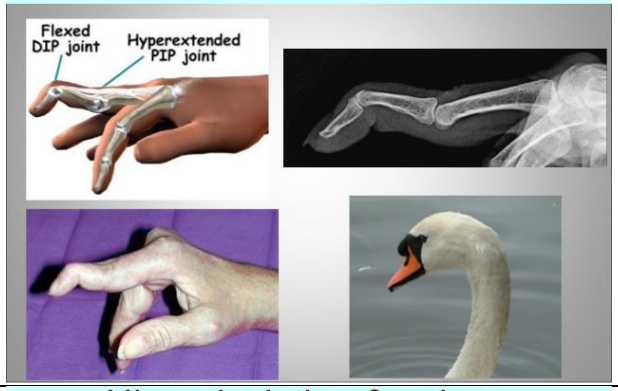
Characteristic Deformities Associated with RA

Name of Deformity	Description
Mallet finger*	Laxity or disruption at the insertion of the extensor tendon on the distal phalanx, thus causing the distal phalanx to drop
Swan-neck deformity	Hyperextension at the proximal interphalangeal joint and flexion at the distal interphalangeal joint
Boutonnière deformity	Flexion at the proximal interphalangeal joint and hyperextension at the distal interphalangeal joint
Hitchhiker deformity	Flexion at the proximal metacarpophalangeal joint and hyperextension at the distal interphalangeal joint

Boutonnière deformity



Swan neck deformity



Mallet finger

- Flexion at the DIJ usually due to extensor tendon injury.

Ulnar deviation & palmar subluxation at MCP joints

Zigzag deformity

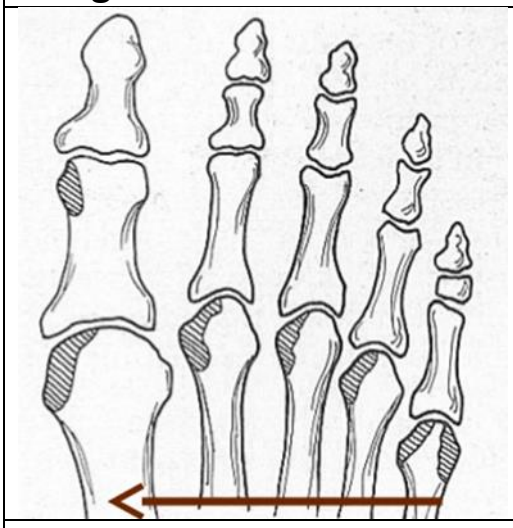
Arthritis mutilans

Sever polyarticular joint deformity

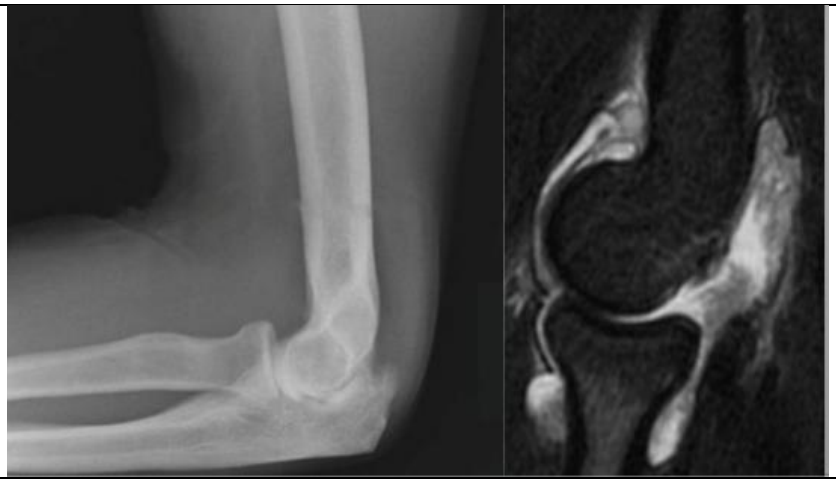
❖RA of Foot

Distribution:

- MTP and PIP joints
- Bilateral and symmetrical

Marginal Erosions	Lanios Deformity
	

❖RA of Elbow



❖RA of Knee

- Joint effusion
- Typically involves the lateral or non-weight bearing portion of the joint
- Loss of joint space involving all three compartments
- Lack of subchondral sclerosis and osteophytes, compared with OA
- Prepatellar bursitis

❖RA of HIP

- **<u>Concentric loss of joint space:</u>** (DD: osteoarthritis (OA) superior loss of joint space)
- **<u>Protrusio acetabuli:</u>**
  - Intrapelvic axial displacement of the acetabulum and femoral head.

<u>DD of Protrusio acetabuli:</u>

P Paget

R Rickets, RA

O Osteogenesis imperfecta, Osteoporosis, Osteomalacia

T Traumatic

❖RA of Shoulder

- Erosion of the lateral clavicle
- Marginal erosions of the humeral head: the superolateral aspect is a typical location
- Reduction in the acromiohumeral distance: "high-riding shoulder" due to subacromial-subdeltoid bursitis and high incidence of rotator cuff tear

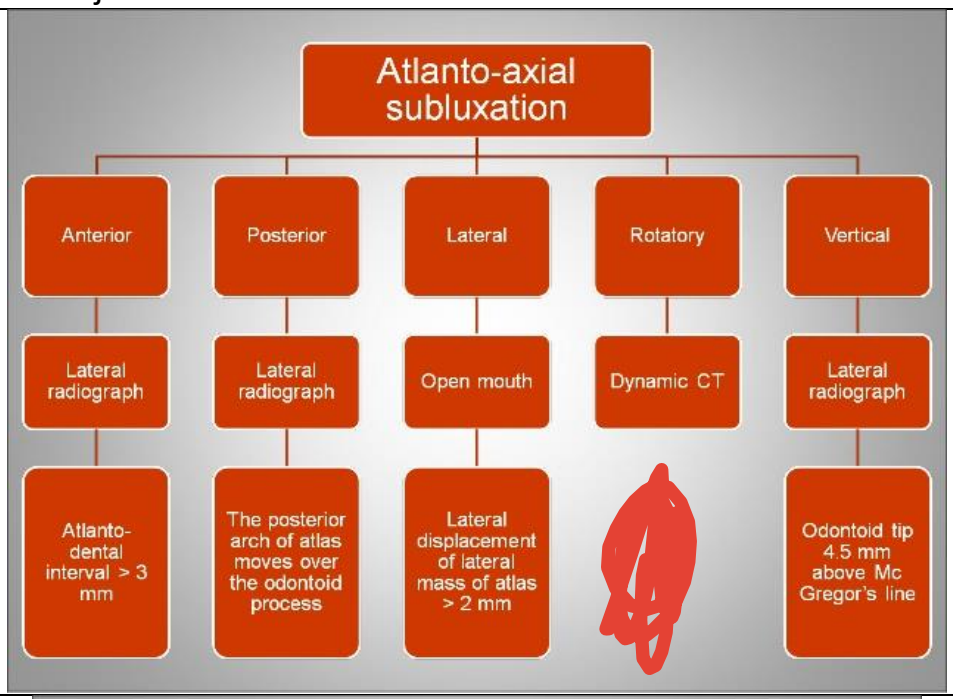
<u>DD: Of lateral clavicular Erosions:</u>

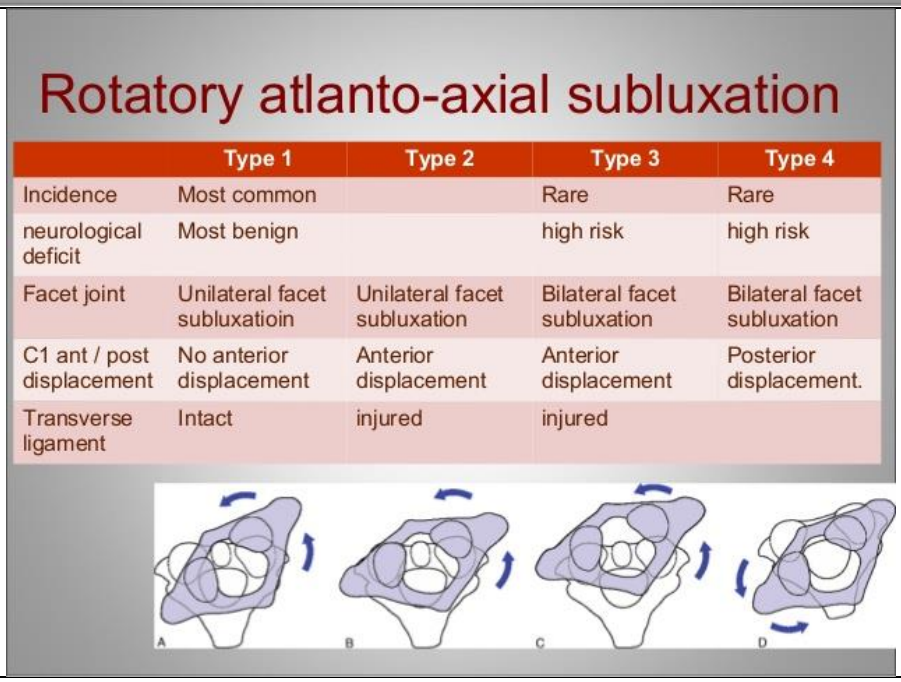
- ✓ Hyperparathyroidism
- ✓ Rheumatoid arthritis
- ✓ Scleroderma
- ✓ Cleidocranial dysostosis
- ✓ Pyknodysostosis (rare)
- ✓ Progeria (rare)
- ✓ Post-traumatic osteolysis

❖RA of Cervical Spine

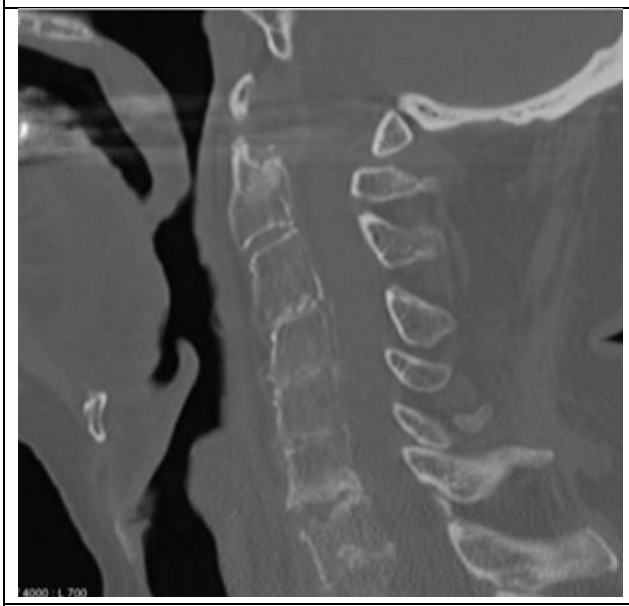
Distribution:

- Odontoid process erosions & basilar Invagination
- Atlanto-occipital joint => Atlanto-occipital sublaxation
- Atlanto-axial joint => Atlanto-axial sublaxation
- Sub-axial joints





Odontoid Process Erosions

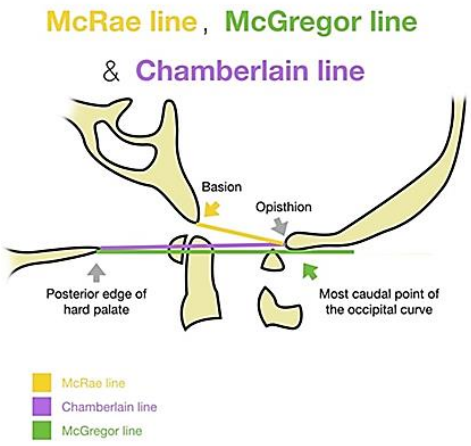


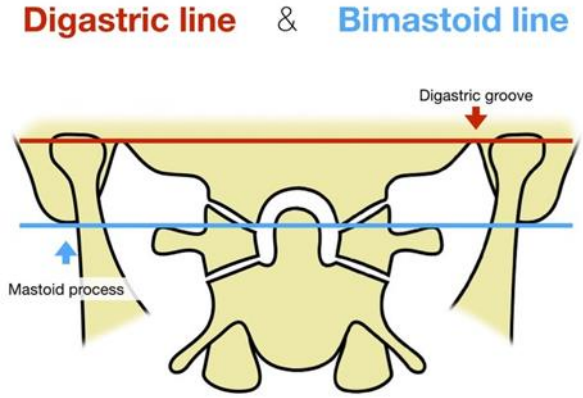
DD: Odontoid process erosions:

- ✓ Inflammatory arthropathy
  - RA
  - SLE
- ✓ Crystal arthropathy
  - Calcium pyrophosphate arthropathy (CPPD): relatively common
  - Gout
- ✓ Infective arthropathy=Osteomyelitis
  - Bacterial
  - Tuberculosis
- ✓ Metastases or primary bone tumour: rare
- ✓ Hyperparathyroidism
- ✓ Down syndrome

Basilar Invagination = Basilar Impression

The tip of the odontoid process projects above the foramen magnum





Congenital

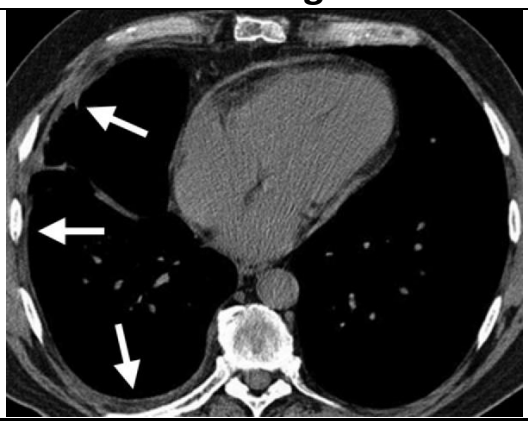
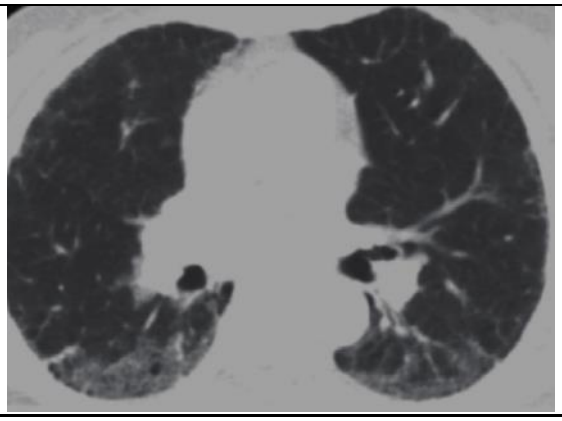
Osteogenesis imperfecta
Klippel-Feil syndrome
Achondroplasia
Chiari I malformation/Chiari II malformation
Cleidocranial dysostosis

Acquired

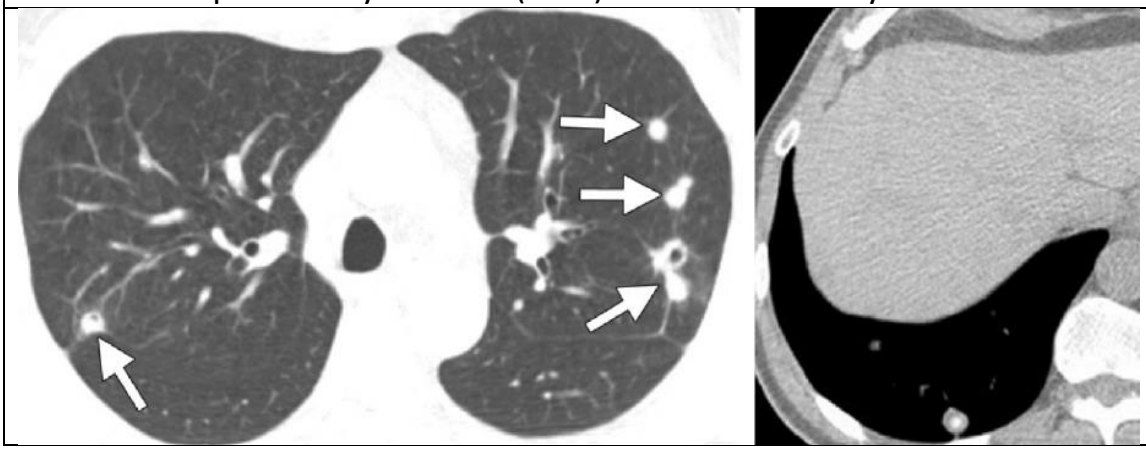
Rheumatoid arthritis
Paget disease
Hyperparathyroidism
Osteomalacia/rickets

❖Respiratory Manifestations of RA

- Pleural: thickening and effusion (most common)
- NSIP = Bi basal GGO + septal thickening
- UIP= Bi basal & peripheral traction bronchiectasis + Honeycombing
- Pulmonary nodules + Cavitation

Pleural thickening & effusion	NSIP
	

Caplan Syndrome = RA + Pneumoconiosis (Silicosis / CWP)
Rheumatoid pulmonary nodules (M>F): Cavitate + Calcify



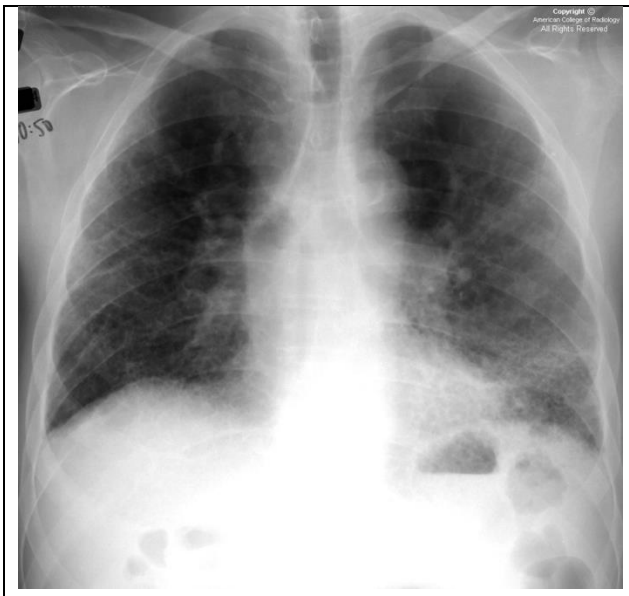
2) Scleroderma

- Scleroderma (progressive systemic sclerosis) is a multisystem connective tissue disorder, which may vary from acute and fulminating to mild and chronic.
- It may form part of the ***CREST syndrome:***
    - Calcinosis, Raynauds phenomenon, esophageal dysmotility, scleroderma and telangiectsasia.

Imaging findings:

- Acroosteolysis: Tuft resorption
- Soft tissue calcifications in pressure areas
- Soft tissue atrophy
- Erosive changes of DIP and PIP

- Lung involvement includes basal fibrosis and aspiration pneumonitis.
- Gastrointestinal involvement involves esophageal dilatation and atony, with gastroesophageal reflux.
- Small bowel shows increased number of folds, “hidebound appearance,” decreased motility, and pseudosacculation.
- MSK: MRI may show an accompanying myositis. There is often overlap with the other connective tissue disorders, such as dermatomyositis; hence, the name mixed connective disease.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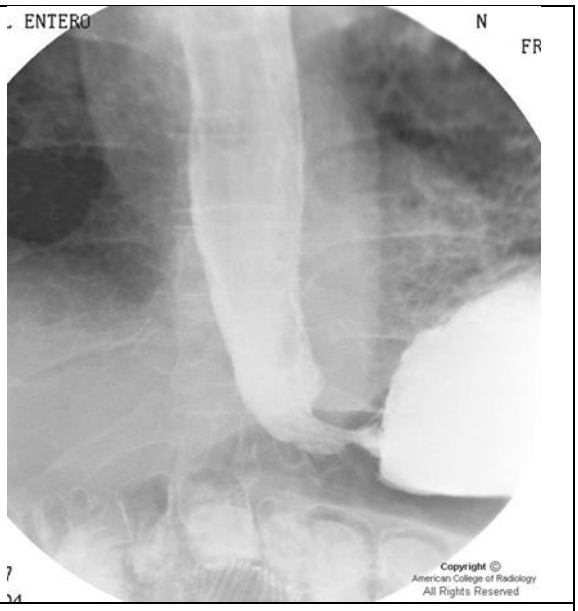
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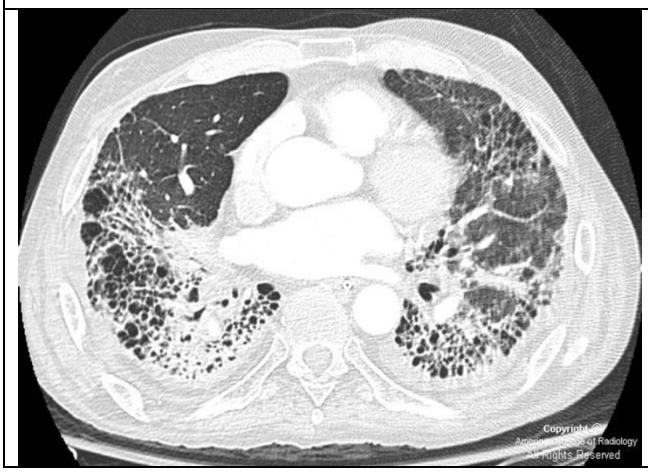
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3) Systemic Lupus Erythematous (SLE)

- ***Deforming non-erosive arthropathy***
- Resulting from ligamentous laxity and joint deformity.
- Radiographically similar to Jaccoud's arthropathy in rheumatic fever

Imaging Findings:

- **Sublaxation of MCP joints**
- **Bilateral and symmetrical**
- **No erosions**

4) Dermatomyositis

- Autoimmune inflammatory myositis

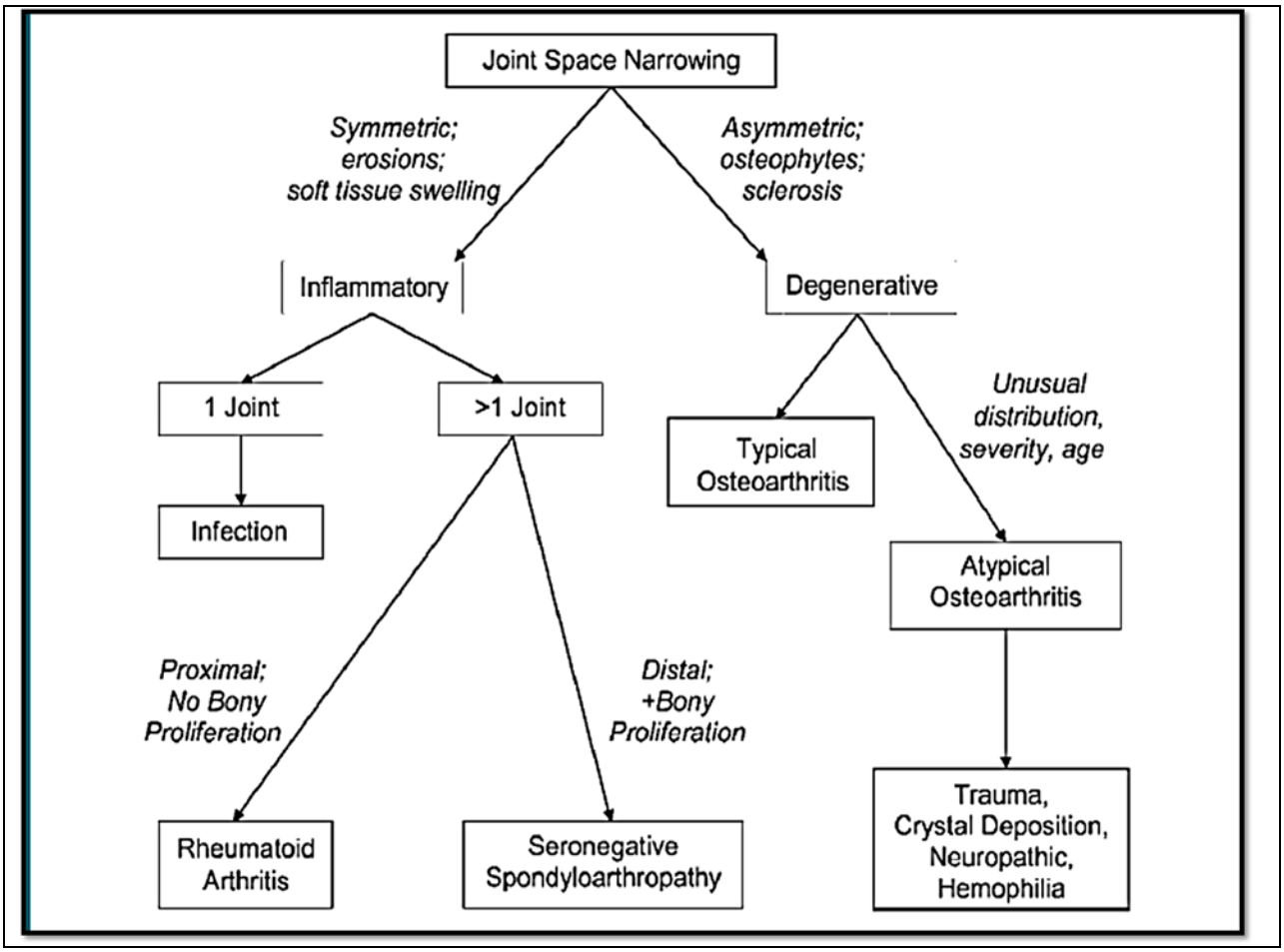
Bimodal age distribution:

- Juvenile dermatomyositis (JDM): affects children and tends to be more severe
- Adult dermatomyositis (ADM): typically affects adults around the age of 50

Imaging findings:

- **Widespread soft tissue calcifications**
- **Acro-osteolysis**

Algorithm for Arthritis ☺



B- Seronegative Spondyloarthritides

Negative to rheumatoid factor

Positive to HLAB27 gene:

1) **Ankylosing Spondylitis : ≈ 90 % HLAB27**
2) **Psoriatic Arthritis : ≈ 60 % HLAB27**
3) **Reiter Syndrome: 80 – 90% HLAB27**
4) **Enteropathic Arthritis: 30% HLAB27**
5) **Undifferentiated Spondyloarthritis**

1) Ankylosing Spondylitis

- Inflammatory arthritis
- Seronegative spondyloarhropathy.
- Negative Rheumatoid factor
- Positive to HLA-B27 gene 90%
- Male > Female = 3:1
- Age: Young Adults = Third decade

Distribution:

- Sacroiliac joints: Bilateral and symmetrical sacroilitis and ankylosis
- Spine
- Large joints

A) Sacroilitis

- Early: Subchondral erosions => Widened SIJ
- Intermediated stage: Subchondral sclerosis.
- Late stage: Ankylosis => Narrowing of SIJ

- **Enthesopathy:** inflammation at the site of tendon or muscle origin or insertion (ASIS, AIIS, Ischial tuberosity) => Wiskering

X-Ray: Modified New York Criteria:

Grade 0: normal sacroiliac joints with well-defined margins;
Grade 1: suspicious changes with incipient sclerosis and decreased focal thickness of the articular space;
Grade 2: minimal abnormality with loss of definition of the articular margins, subchondral osteoporosis, and areas of reactive sclerosis.
Grade 3: unequivocal abnormality with subchondral sclerosis of both sacral and iliac articular margins (predominantly on the iliac side), erosions, reduced articular space, widening of the joint space, and incipient ankylosis;
Grade 4: complete ankylosis with residual sclerosis, which tends to decrease over time.

CT Grading of Sacroilitis:

Grade IA: SIJ space > 4 mm
Grade IB: SIJ space < 2 mm
Grade IIA: contour irregularities
Grade IIB: erosions (appearing early in the iliac aspect and later on the sacral side)
Grade IIIA: significant subchondral sclerosis
Grade IIIB: spur formation
Grade IVA: transarticular bone bridges
Grade IVB: total ankylosis

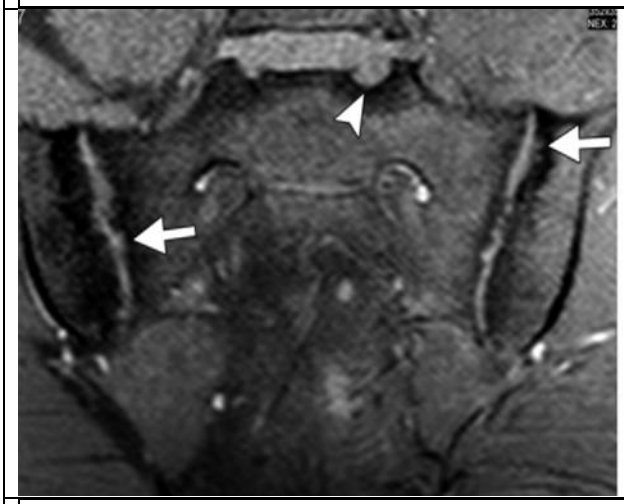
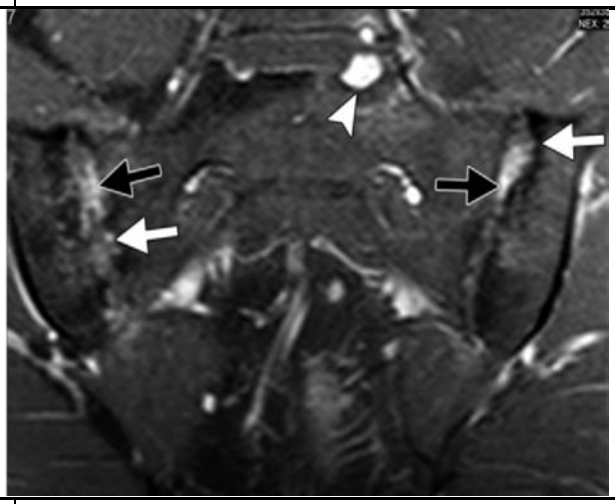
MRI Protocol:

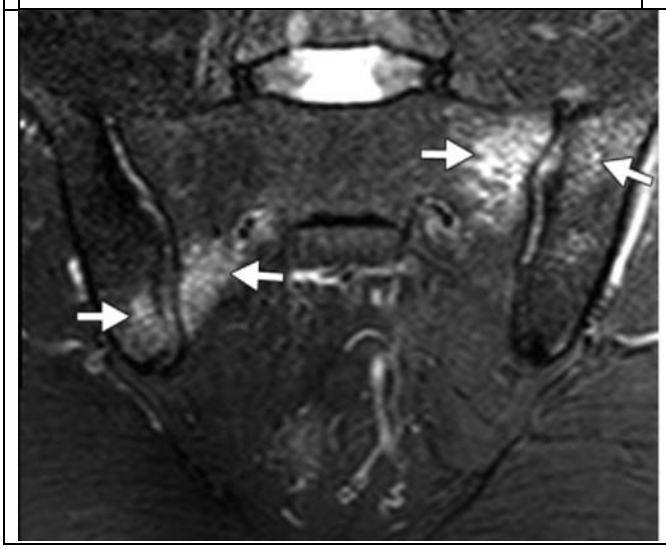
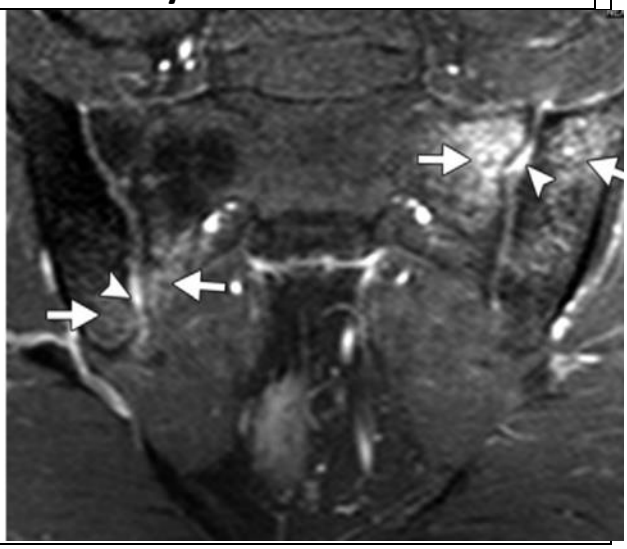
- Coronal and axial oblique FSE T1 to detect structural changes.
- Coronal and axial oblique STIR to detect acute inflammatory changes.
- Post contrast fat-saturated FSE T1 to detect active inflammatory changes.

i) Active Sacroilitis:

- Synovitis = Inflammation of the cartilagenous part
- Capsulitis = Inflammation of the fibrous part
- Enthesitis = Inflammation of the ligamentous part
- Periarticular Bone marrow edema

Synovitis: can be differentiated from joint fluid only by enhancement in the synovial part of the joint

Pre-contrast	Post-contrast
	

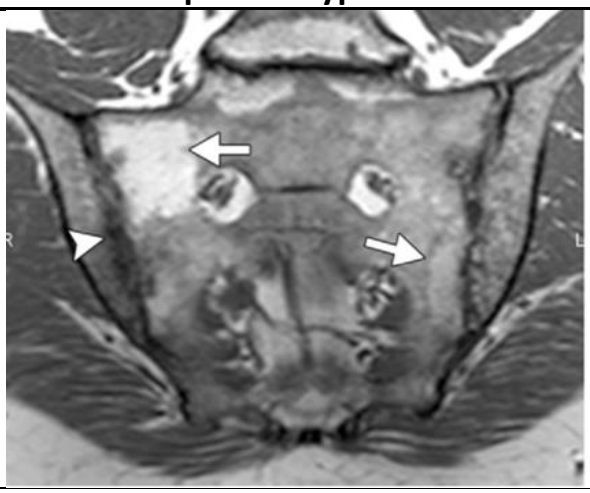
Coronal STIR: BM edema	**T1+C FS: Synovivits**
	

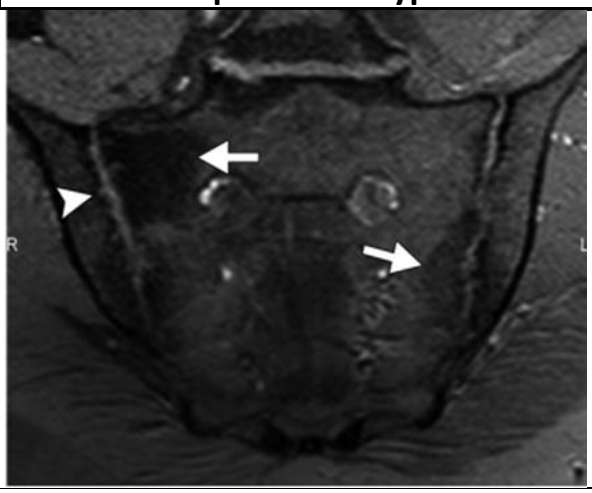
ii) Intermediate sacroilitis = Erosions + Production

- **Subchondral sclerosis**
- **Subchondral Erosions**
- **Periarticular fat deposits**

Periarticular fat deposits:

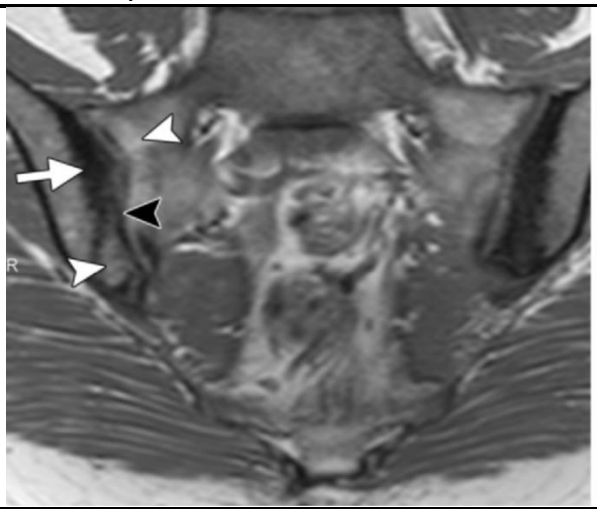
Coronal oblique T1: Hyperintense	**Coronal oblique T1 FS: Hypointense**

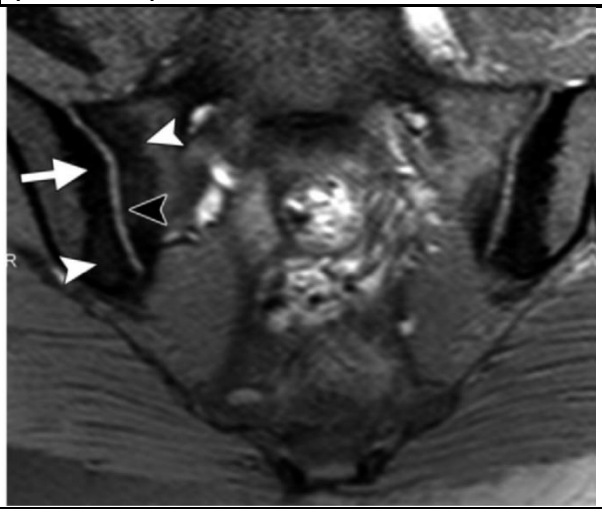


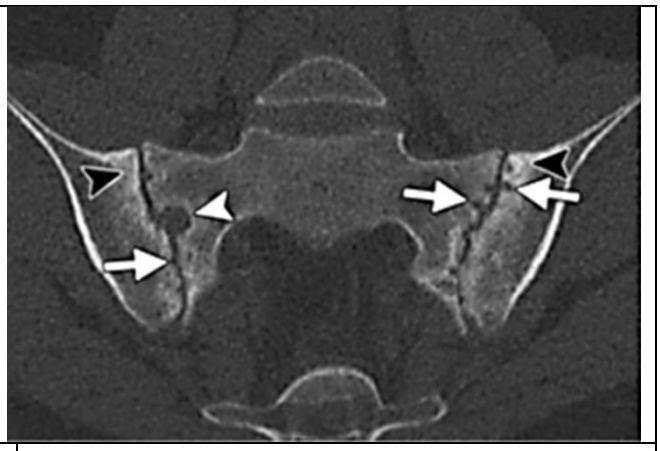
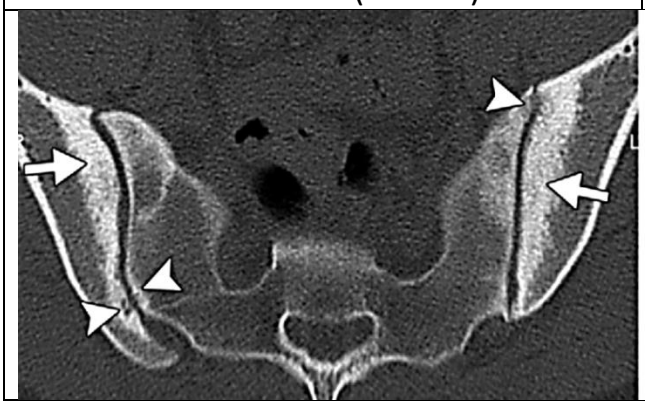


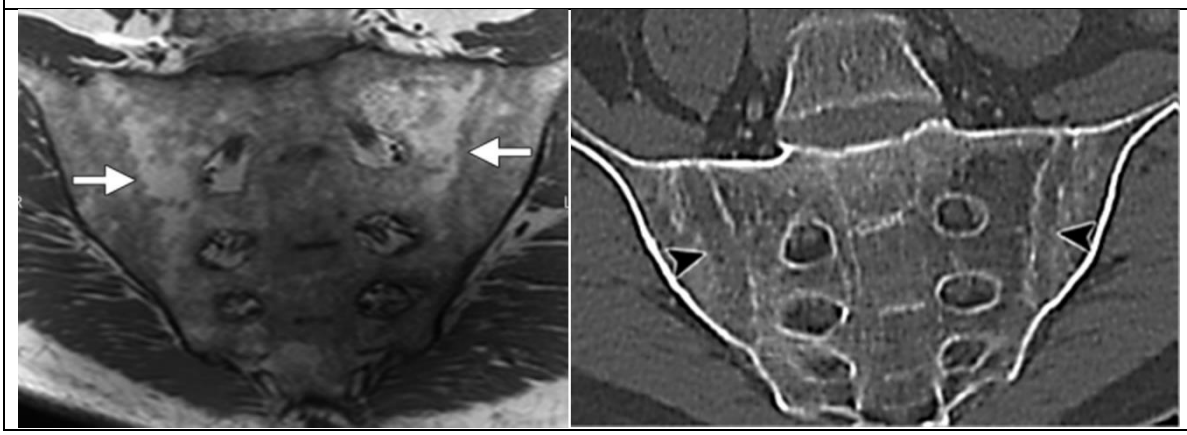
Subchondral Sclerosis:

Coronal oblique T1: low signal in all pulse sequences.	Coronal oblique STIR: low signal in all pulse sequences.





➢ Diffuse decrease in the size of both SIJ spaces ➢ Multiple bilateral small erosions (arrows), ➢ Bilateral subchondral sclerosis (black arrowheads).	
Diffuse decrease in the size of both SIJ spaces Small erosions (arrowheads), Subchondral sclerosis (arrows).	"Pseudowidening" of left SIJ space (white arrowhead) Calcification of the anterior capsule (black arrowhead)
	

iii) <u>Chronic sacroilitis = Ankylosis:</u>
Coronal oblique T1 shows complete fusion of both sacroiliac joints (arrows).


B) Spine

- Romanus lesions of the spine - shiny corner sign
- Andersson lesions of the spine
- Squaring of the vertebral body
- Syndesmophytes.
- Dagger spine
- Trolley-track" sign
- Bamboo spine
- Chalk stick fracture
- Pseudoarthroses may form at fracture sites.

Classification of Changes in Spondyloarthritis of the Vertebral Column as Seen on MR Images

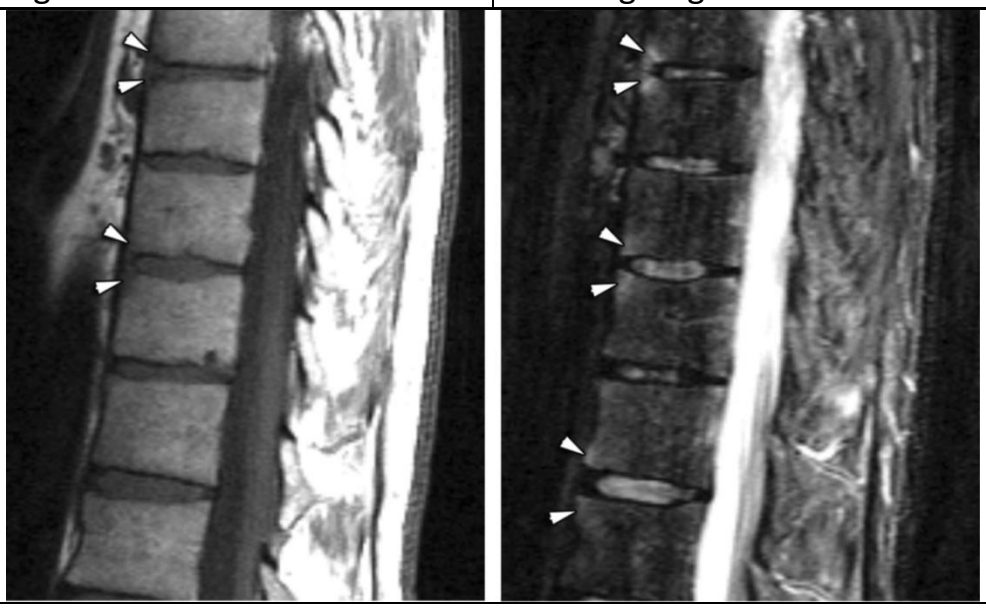
Class	T1-weighted Image	T2-weighted or STIR Image	Interpretation
0	Vertebra: intermediate SI Disk: low SI	Vertebra: low SI Disk: high SI	Normal findings
1	Vertebra: low SI Disk: low SI	Vertebra: high SI Disk: high SI	Florid inflammatory changes
2	Vertebra: high SI Disk: low SI	Vertebra: low SI Disk: high SI	Chronic postinflammatory fatty bone marrow degeneration
3	Vertebra: intermediate SI Disk: intermediate SI	Vertebra: low SI Disk: low SI	Partial or complete ankylosis

i) Romanus Lesion

- Irregularity and erosion involving the anterior and posterior edges of vertebral endplates

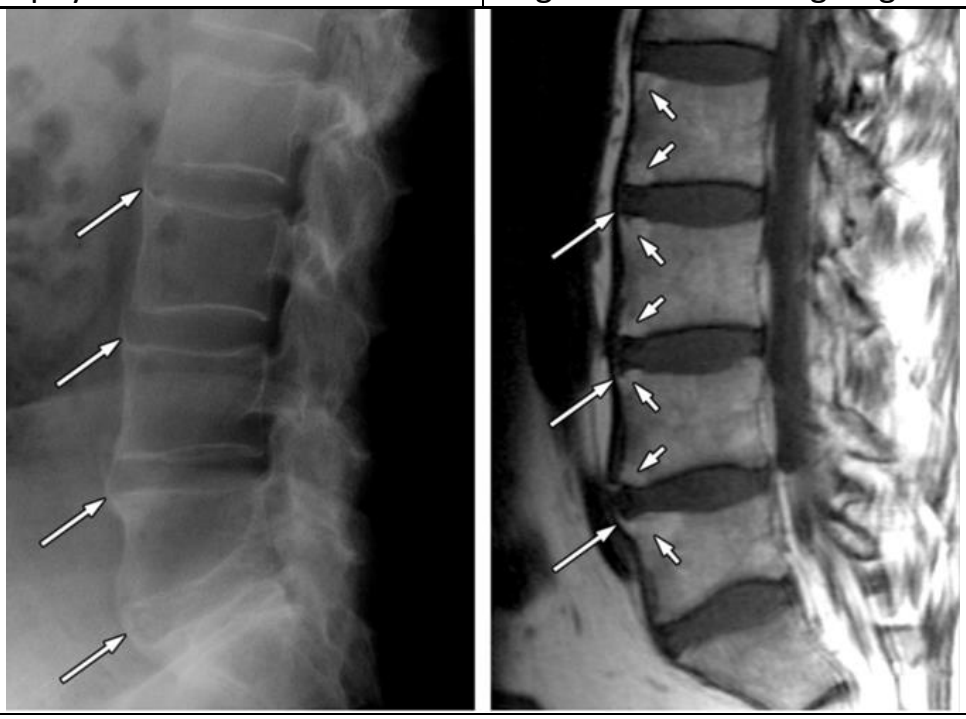
Florid/Active Romanus Lesion

T1: Low signal anterior corners	STIR: high signal



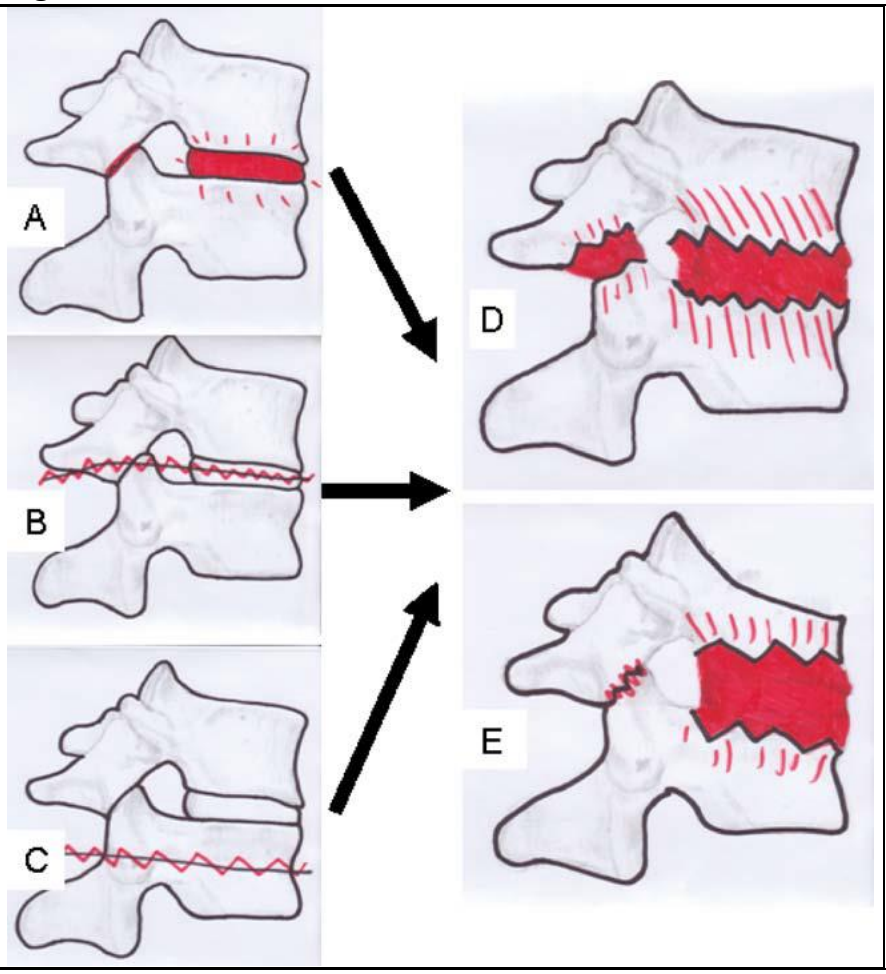
Inactive Romanus Lesion

Shiny sclerotic corners Syndesmophytes	Postinflammatory fatty marrow degeneration = T1 high signal

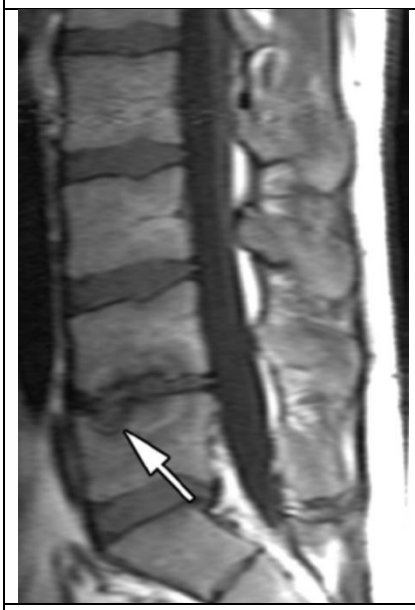
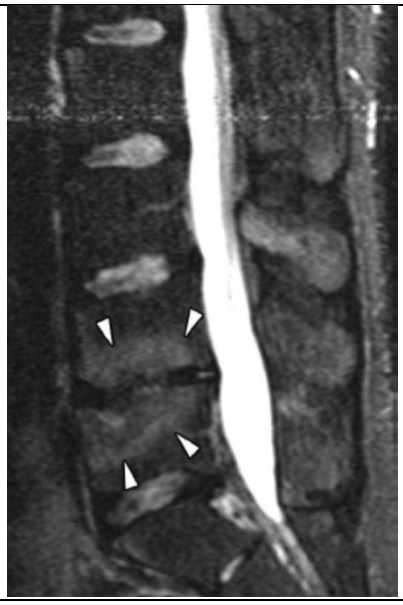
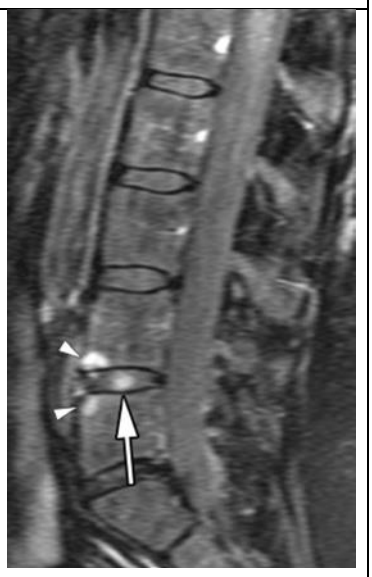


ii) Andersson lesion

Andersson lesions may originate from:

Inflammation of the intervertebral discs = spondylodiscitis	
Noninflammatory Insufficiency Fracture through the ankylosed disc	
Noninflammatory Insufficiency Fracture through Vertebral body	

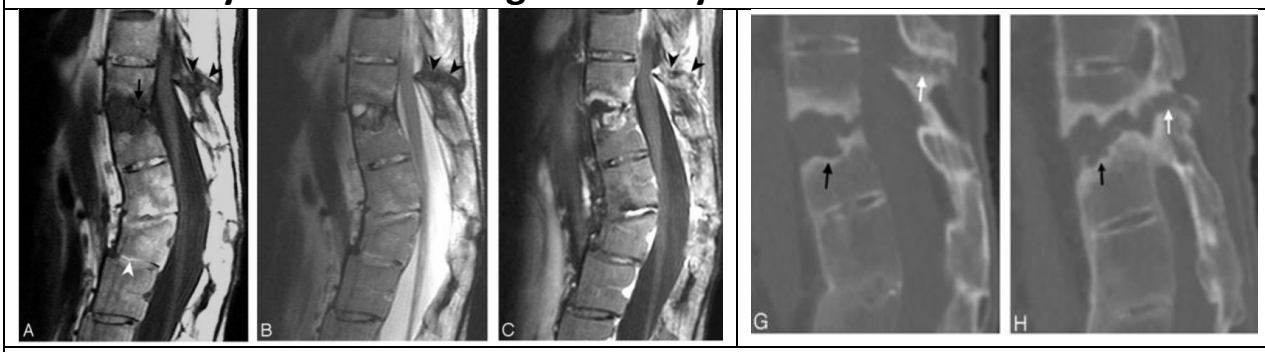
Active/Florid Andersson Lesion

T1: Low signal	STIR: High signal	T1+C+FS: Enhancement (arrow) of intervertebral disk
		

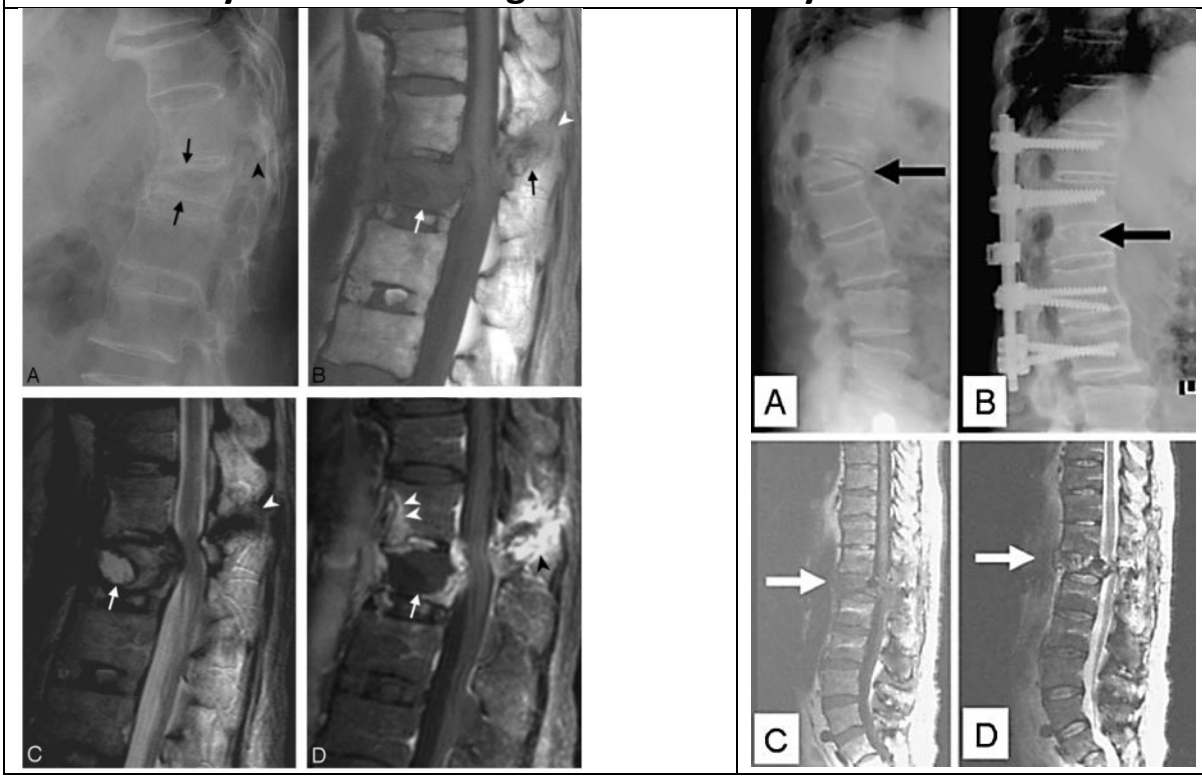
Inactive/Postinflammatory Andersson Lesion

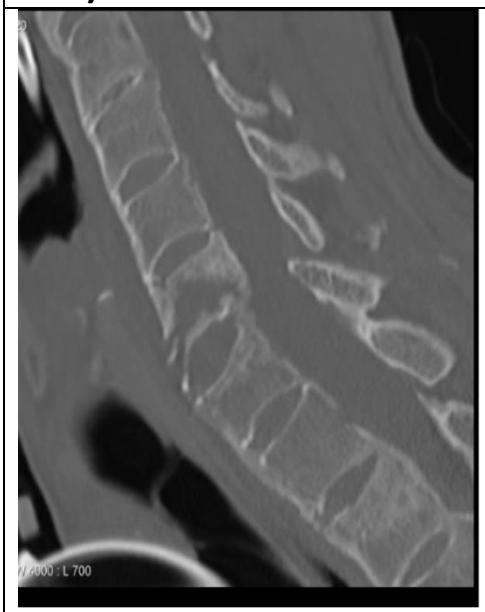
T1: High signal	STIR: Low signal

Non-inflammatory Andersson Lesion
Insufficiency Fracture through the ankylosed disc



Non-inflammatory Andersson Lesion
Insufficiency Fracture through vertebral body



iii) Syndesmophytes	iv) Enthesitis
Calcification of the annulus fibrosis at disco-vertebral level: Nonmarginal- vertical- Floating	Inflammation, thickening and enhancement at the bony attachment of ligaments and tendons.
v) Chalk stick fracture	**vi) Pseudoarthrosis**
	

vii) Dagger sign	viii) Trolley track spine
Midline vertical density = Ossification of the posterior interspinous/supraspinous ligaments	3 lines: Midline vertical line = Ossification of interspinous/supraspinous ligaments Lateral vertical lines = Ossification of the apophyseal joints capsule
ix) Bamboo spine	
Complete fusion of all vertebral bodies	Fusion secondary to Syndesmophytes

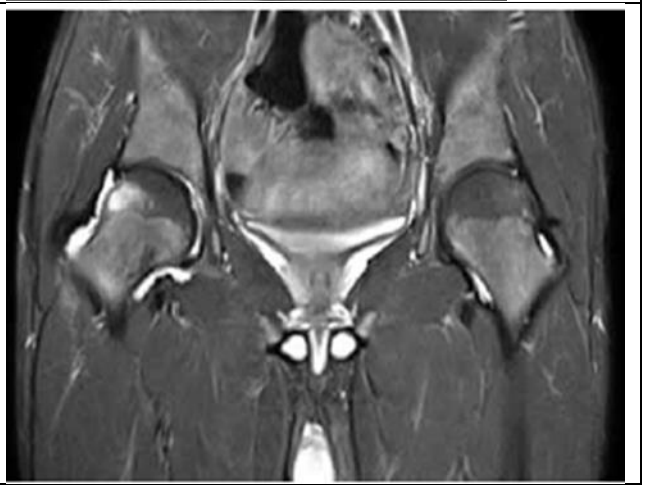
C) Joints

Distribution:

- Large Joints > Small Joints
- Proximal joints > Distal joints
- Unilateral > Bilateral
- The hip joint is most commonly involved

Radiological Findings:

- Concentric Joint space narrowing
- Juxta-articular osteopenia
- Marginal erosions
- Femoral osteophytosis and subchondral sclerosis.



2) Psoriatic Arthritis

- Inflammatory arthritis
- Seronegative spondyloarhropathy.
- Negative Rheumatoid factor
- Positive to HLA-B27 gene 60%
- Female > Male

5 Patterns:

a) Asymmetrical oligoarthritis = Sausage digit
b) Classic asymmetrical polyarthritis.
c) Symmetrical polyarthritis (as RA)
d) Spondyloarthropathy of SIJ and spine: unilateral and asymmetrical involvement of SIJ (DD: AS)
e) Arthritis mutilans: is a very destructive form of psoriatic arthritis with significant periarticular bone resorption.

Distribution:

- Combination of erosive and productive bone changes.
- Distal distribution (DIP > PIP > MCP joints).
- Hands > feet.
- Affect sacroiliac joints and spine.
- Skin and nail changes.

Radiological Findings:

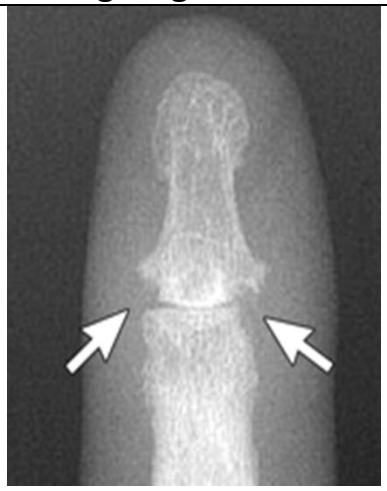
- "Pencil-in-cup" deformities are common, not pathognomonic
- Mouse ears = Marginal erosions + Bone proliferation
- Periostitis : a periosteal layer of new bone, or as irregular thickening of the cortex itself
- Dactylitis : “sausage digit” = soft tissue swelling of a whole digit.
- Arthritis mutilans : A severe form of PSA or rheumatoid arthritis caused by marked bony resorption and the consequent collapse of soft tissue; when this affects the hands, it can cause A phenomenon sometimes referred to as "telescoping fingers."
- “Ivory phalanx” : classically involving the distal phalanx of the great toe
- Sacroiliitis : bilateral and asymmetrical
- Spondylitis : asymmetric paravertebral ossifications and relative sparing of the facet joints

Nail Changes

Skin Changes

Pencil in Cup deformity:

Mouse ears
Sausage digit



Tuft erosions
Periostitis

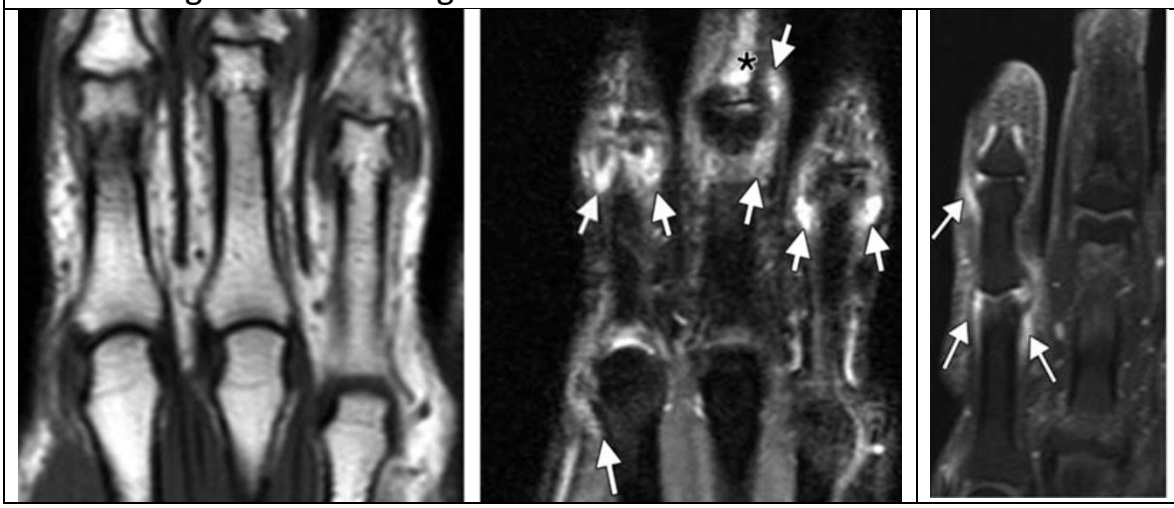
Arthritis Mutilans:

MR imaging:

- **Enthesitis**: Diffuse bone marrow edema at the attachment of ligaments and tendons, as well as florid inflammatory soft tissue changes at this site.
- **Periostitis:** thickening and contrast enhancement of the periosteum
- **Bone marrow edema**: observed in the diaphysis of the phalanges at a considerable distance from the subchondral bone and the capsular joint entheses.
- **Synovitis:** is not a predominant feature in most peripheral spondyloarthropathies.

Synovial enhancement of DIP & PIP

Enthesitis: Soft-tissue high STIR signal and enhancement at the entheses surrounding the collateral ligaments of the DIP and PIP



3) Reiter's Syndrome

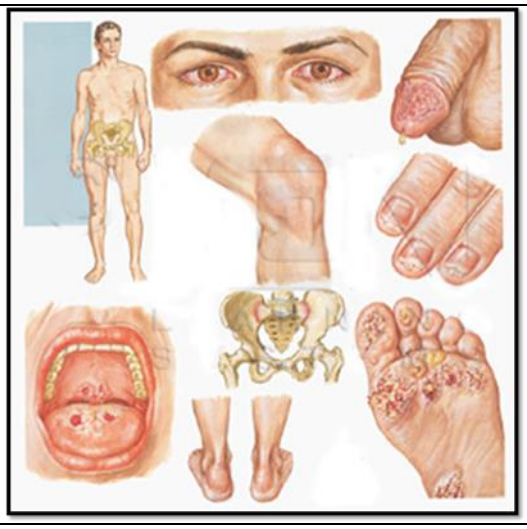
- Inflammatory arthritis
- Seronegative spondyloarhropathy.
- Negative Rheumatoid factor
- Positive to HLA-B27 gene 80%
- Male > Female

Clinical Triad:

Arthritis + Conjunctivitis + Urethritis

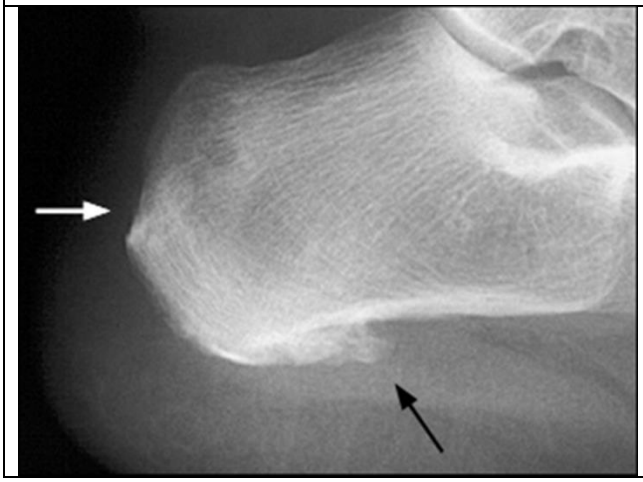
Distribution:

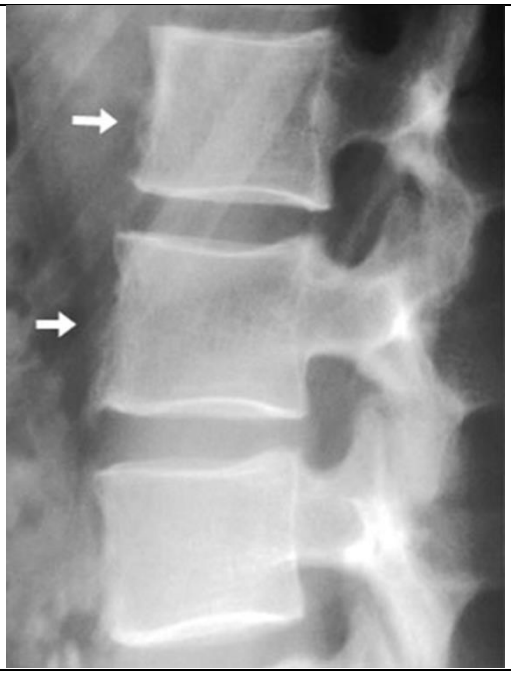
- LL > UL
- Distal distribution
- MTP > Calcaneus > Knee joints.
- Bilateral asymmetrical sacroilitis.
- Spine



Calcaneus:

- Enthesopathy + Erosions at the Achilles tendon insertion (white arrow)
- Enthesopathy + Erosions at the plantar fascia insertion (black arrow)
- Retrocalcaneal bursitis



Foot: Erosions of MTP joints Subluxation and valgus deformity of most of the toes.	
	
SIJ: Bilateral & asymmetrical sacroilitis.	

4) Enteropathic arthritis (EA)

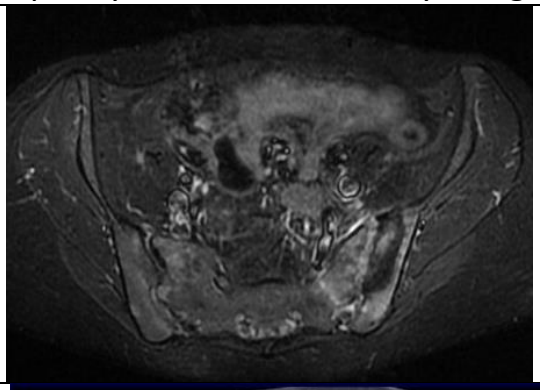
- Chronic, inflammatory arthritis
- Seronegative spondyloarthropathy.

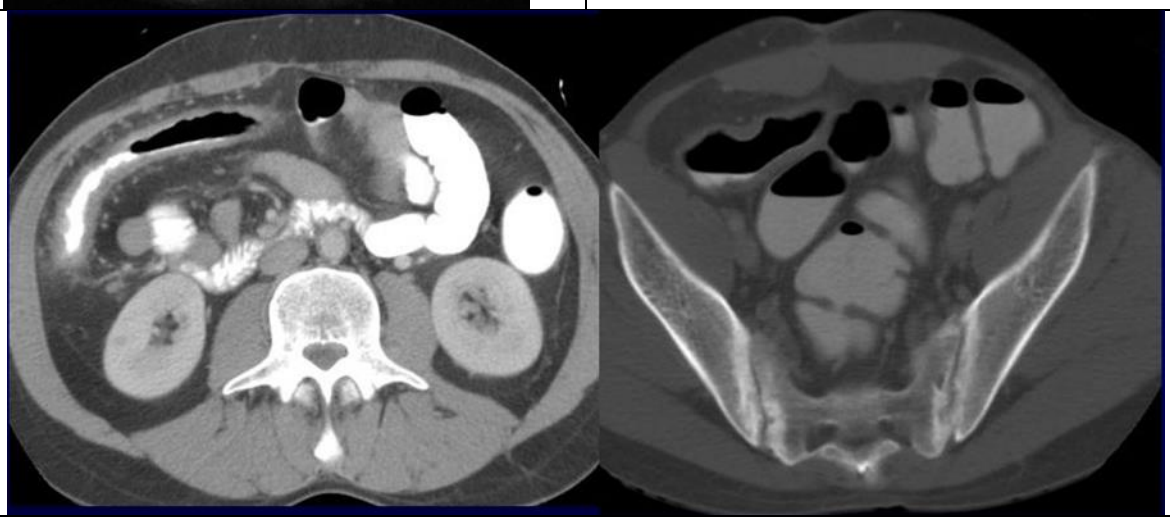
Associated with :

- **Inflammatory bowel disease (IBD):** 20% of people with Crohn disease or ulcerative colitis may develop enteropathic arthritis
- Infectious enterocolitis
- Whipple disease
- Coeliac disease
- Intestinal bypass surgery

Distribution:

- Peripheral joint arthritis
- Sacroiliitis
- Spondylitis identical to ankylosing spondylitis





C) Erosive Osteoarthritis

- EOA is a form of osteoarthritis + erosive / inflammatory component
- F : M= 12 : 1
- Age: Postmenopausal period
- Rheumatoid factor negative

Distribution:

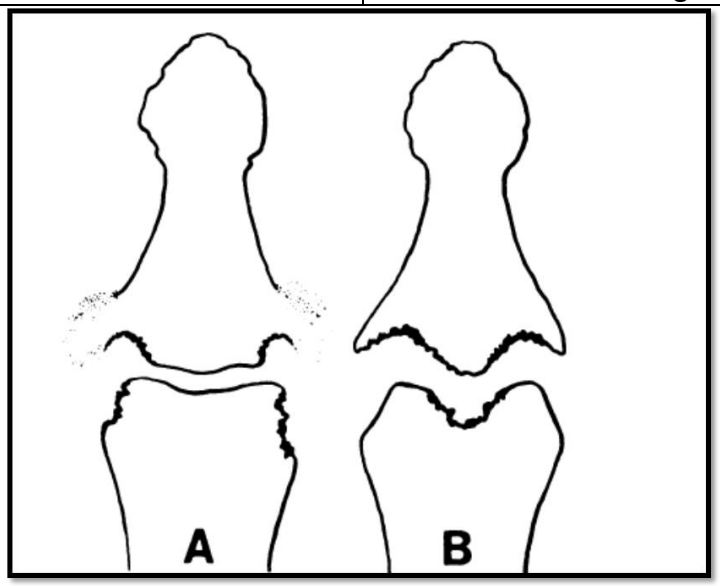
A predilection for the **hands:**

- DIP joints
- PIP joints
- 1st CMC joint

Radiological Findings:

- Diffuse joint space loss
- **Gull wing appearance = DIP joint Central erosions + Marginal osteophytes**
- Joint ankylosis
- **No** Marginal erosions
- **No** Fusiform soft-tissue swelling
- **No** Osteopaenia

Psoraisis:	**EOA:**
Mouse ears erosions = Bare area Marginal erosions	Gull wing Central erosions + Marginal osteophytes



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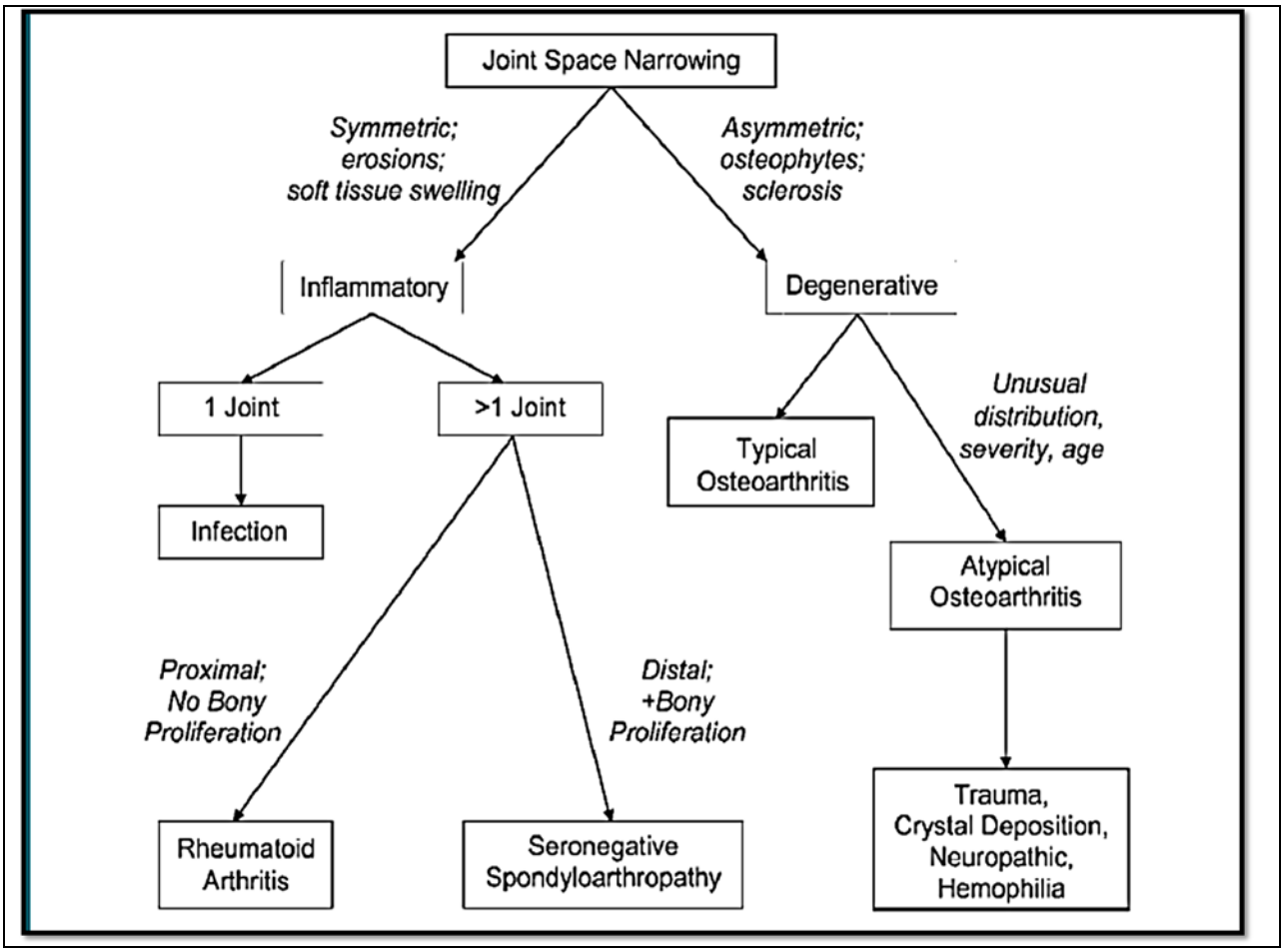
Algorithm for Arthritis ☺



II- Infectious Arthritis

Subdivided into:

- **Septic (Pyogenic) arthritis:**
  - mostly due to Staphylococcal and Gonococcal organisms
- **Non-pyogenic arthritis:**
  - mostly due to infection with Mycobacterium tuberculosis.

Risk factors:

- Bacteraemia
- Advanced age
- Immunocompromised state
- Rheumatoid arthritis
- Intra-articular injections
- Prosthetic joints.
- Recent joint trauma
- Joint surgery.

Source of Infection:

- Hematogenous seeding from an infected source elsewhere in the body, such as a wound infection
- Direct, contiguous extension from osteomyelitis adjacent to the joint

Clinical presentation:

- Painful joint, fever, and purulent synovial fluid.

Location => Monoarticular / Big Joints

- Large joints with abundant blood supply to the metaphyses are most prone to bacterial infection
  - Shoulder, hip, and knee.
- In intravenous drug abusers:
  - Sternoclavicular and sacroiliac joints.
- Hands may be infected from human bites
- Feet from diabetes

A- Septic Arthritis

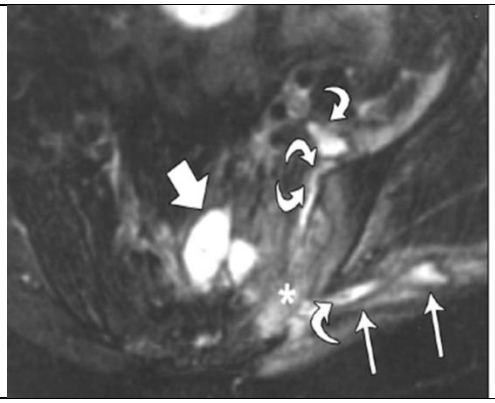
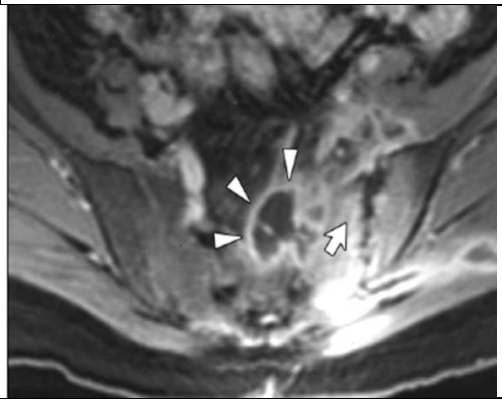
Radiographic findings:

- X-rays may be normal in the very early stage of the disease
- Soft tissue swelling (due to joint effusion)
- juxta-articular osteoporosis (due to hyperaemia)
- Narrowing of the joint space (due cartilage destruction in the acute phase)
- Ill defined central and marginal erosions.
- Destruction of the subchondral bone on both sides of a joint

MRI

- T1: Low signal within subchondral bone marrow edema
- T2: joint effusion + Perisynovial oedema + Bone marrow edema
- C+: Synovial enhancement

SIJ:

Axial STIR	Axial T1+C FS
	

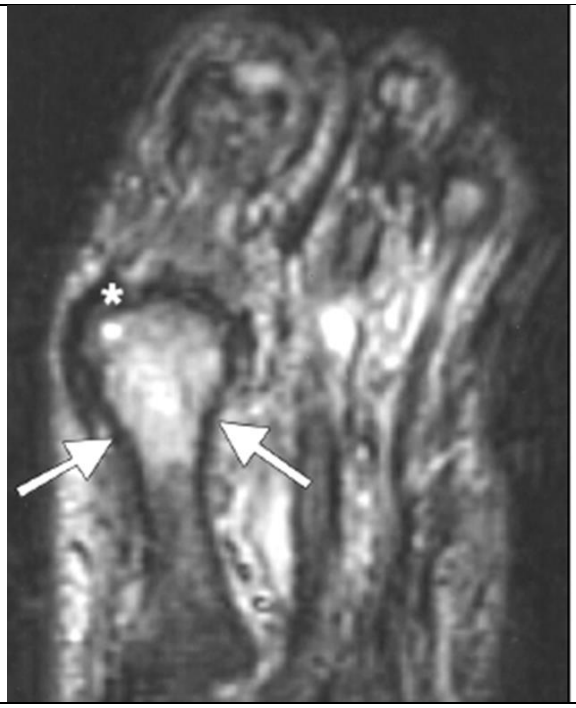
Hip:

Coronal T1	Coronal STIR

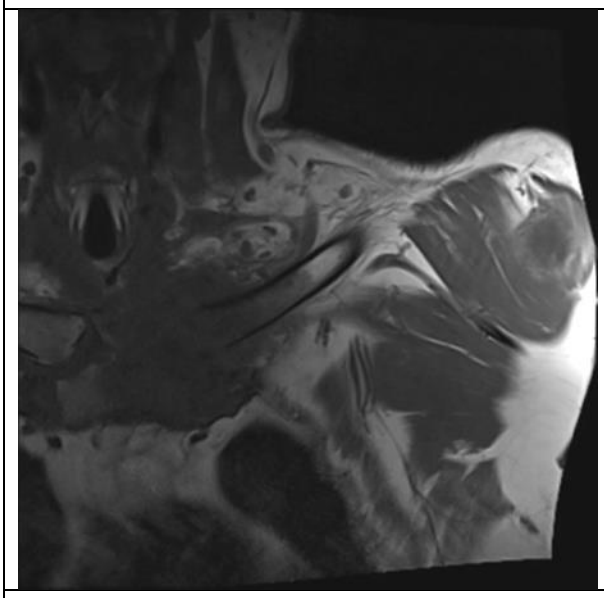
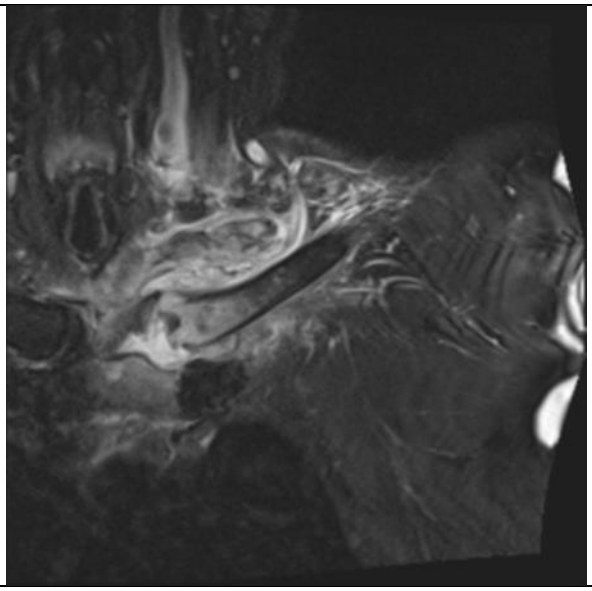
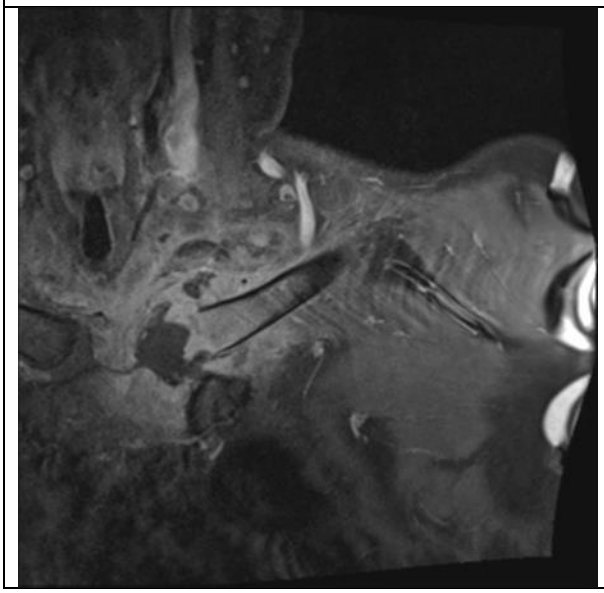
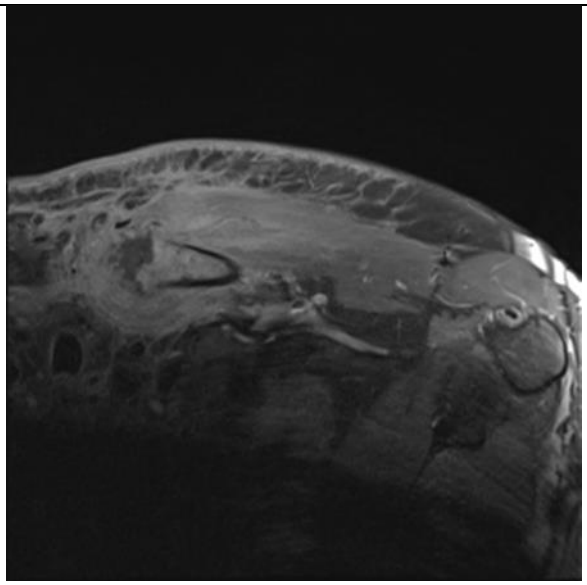
Knee:

Sagittal T1+C	Sagittal T1 +C FS

1st Metatarso-phalyngeal Joint

Coronal STIR	Coronal T1 +C
	

Sterno-Clavicular Joint

Coronal T1	Coronal STIR
	
Coronal T1+C FS	**Axial T1+C FS**
	

B- Tuberculous Arthritis

Causative Organism:

Mycobacterium Tuberculosis

Route of infection:

- Hematogenous spread of an active pulmonary or lymphatic focus of tuberculosis to the synovium;
- Direct spread from an adjacent focus of osteomyelitis

Location => Monoarticular; Large Joints

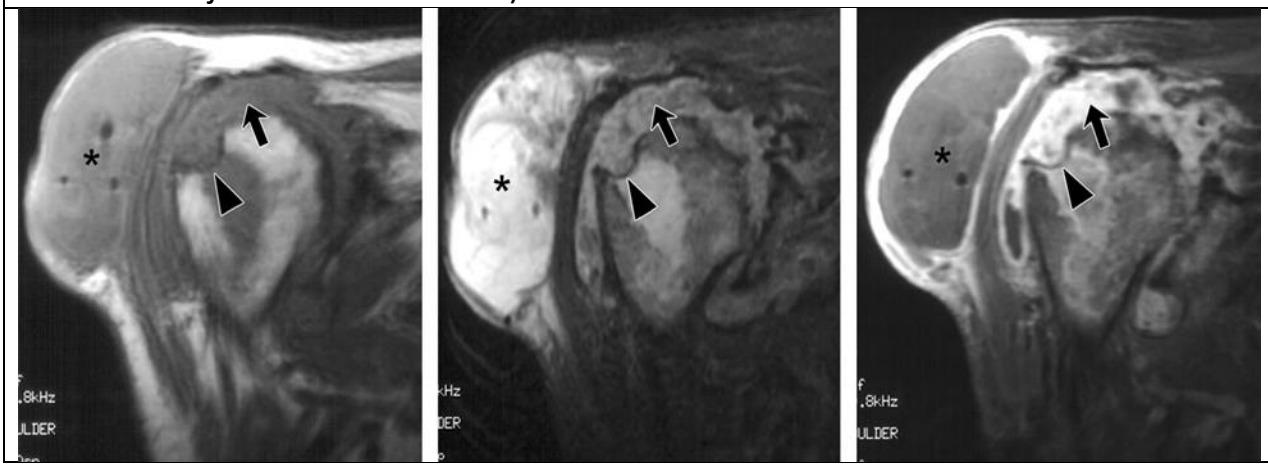
- Spine
- Followed by hip and knee

Early Radiographic Findings => Phemister's triad include:

- Peri-articular osteoporosis
- Peripherally located osseous erosion
- Gradual diminution of the joint space

Late stages (stage of erosion and destruction)

- Gradual narrowing of joint space (there is involvement of articular cartilage)
- Severe subchondral erosion and destruction
- Pathological subluxation and dislocation
- Fibrous ankylosis - in contrast to pyogenic arthritis, the development of bone ankylosis is uncommon in tuberculous arthritis and, when present, is more likely to be secondary to prior surgical intervention
- Atrophic changes in bones may occur and lead to atrophic arthropathy (seen in shoulder joint as carries sicca)



TB Arthritis of HIP

Classification

Table 2: Clinicoradiological classification of tuberculosis of the hip

Stages	Clinical findings	Radiologic features
Synovitis	Flexion, abduction, external rotation, apparent lengthening	Haziness of articular margins and rarefaction
Early arthritis	Flexion, adduction, internal rotation, apparent shortening	Rarefaction, osteopenia, bony erosions in femoral head, acetabulum or both. No reduction in joint space
Advanced arthritis	Flexion, adduction, internal rotation, shortening	All of the above and destruction of articular surface, reduction in joint space
Advanced arthritis with subluxation/ dislocation	Flexion, adduction, internal rotation with gross shortening	Gross destruction and reduction of joint space, wandering acetabulum

Source: Tuli, Tuberculosis of Skeletal System, 4th ed., 2010. p. 72

Shanmugasundaram's Classification

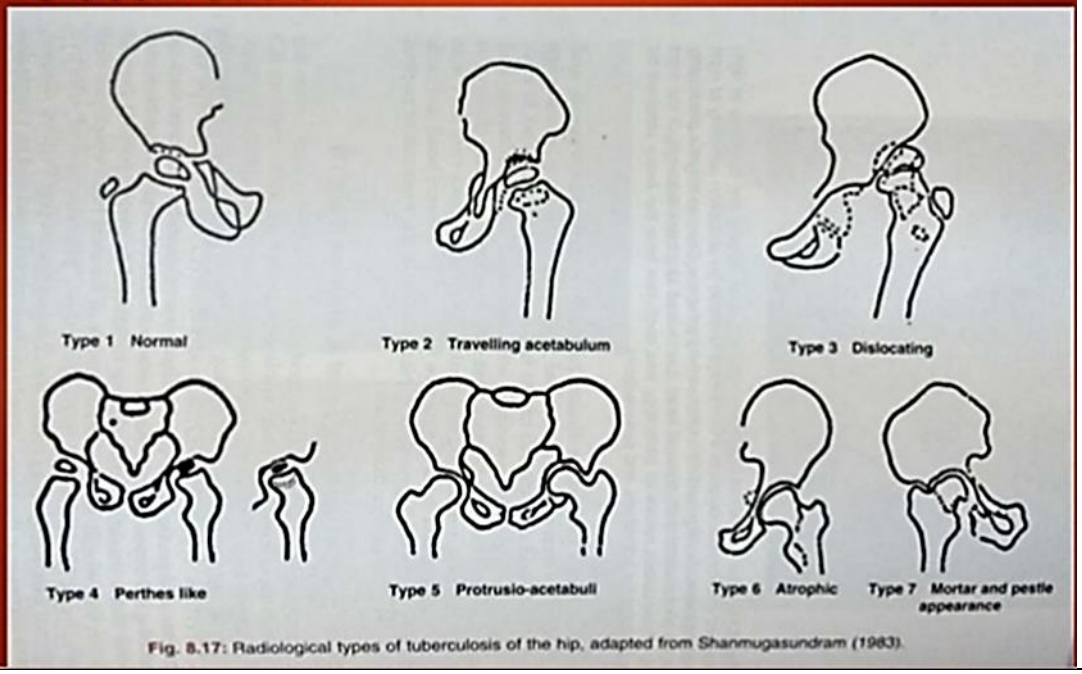
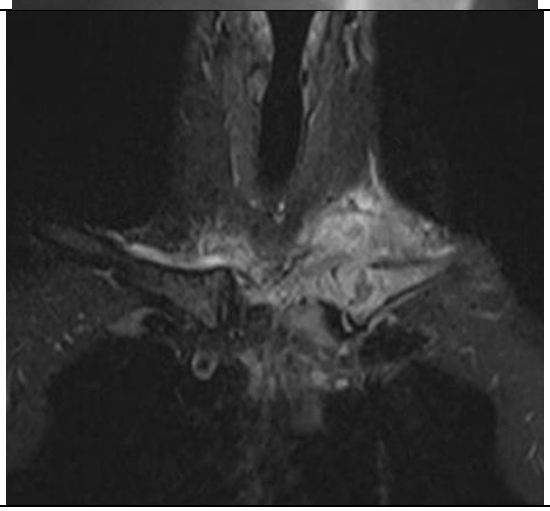
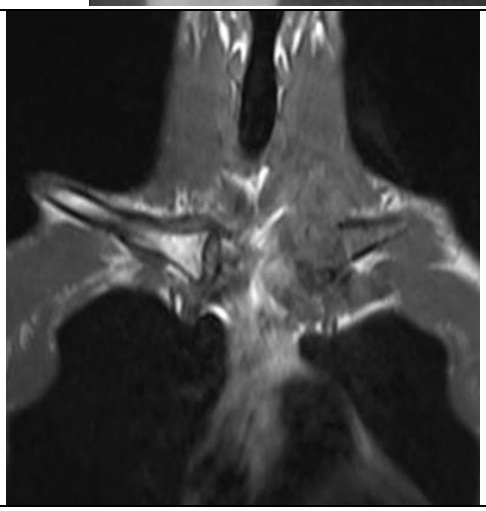


Fig. 8.17: Radiological types of tuberculosis of the hip, adapted from Shanmugasundram (1983).

Perthes like	Wandering Acetabulum
	

III- Juvenile Idiopathic Arthritis (JIA)

- The Classic term of juvenile rheumatoid arthritis JRA is being replaced by the term juvenile idiopathic arthritis (JIA)
- Juvenile idiopathic arthritis (JIA) is the most common chronic arthritis of children.

Location and Distribution => Large joints

- knee, hip, spine, wrist, ankle, and temporal mandibular joints.

International League of Associations for Rheumatology (ILAR)

Category	Definition
Systemic arthritis	One or more joints affected with or preceded by at least 2 weeks of fevers that have been daily for at least 3 days, with at least one of the following: transitory rash, generalized lymphadenopathy, hepato- or splenomegaly, or serositis
Oligoarthritis	One to four joints affected within 6 months of onset
Polyarthritis (RF negative)	Five or more joints affected within 6 months of onset, with a negative RF test result
Polyarthritis (RF positive)	Five or more joints affected within 6 months of onset, with two positive RF test results at least 3 months apart within 6 months of disease onset
Psoriatic arthritis	Arthritis and psoriasis, or arthritis and two or more of the following: dactylitis, nail pitting or onycholysis, or psoriasis in a first-degree relative
ERA	Arthritis and enthesitis, or arthritis or enthesitis with two or more of the following: presence or history of sacroiliac joint tenderness or inflammatory low back pain; positive HLA-B27 antigen; male over 6 years of age at onset; acute (symptomatic) anterior uveitis; or a history of ankylosing spondylitis, ERA, sacroiliitis with IBD, Reiter syndrome, or acute anterior uveitis in a first-degree relative
Undifferentiated	Fits into none or at least two of the other categories

ACR criteria

- Age limit (< 16 y)
- Duration of disease (>6 months)
- They also recognize 3 types of onset:
  - Polyarthritis, Oligoarthritis, And Systemic (Still Disease).

1) Oligoarthritis

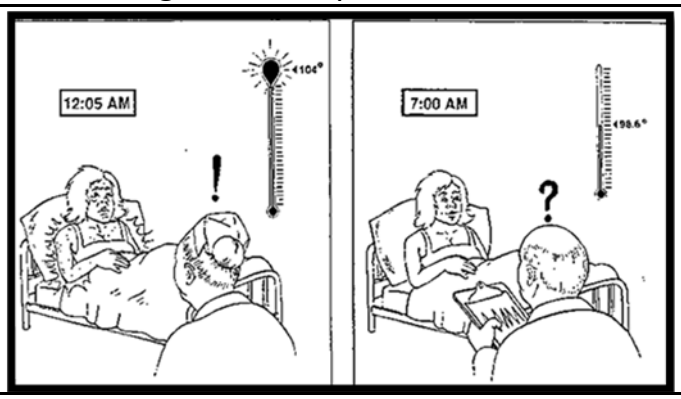
- 1-4 joints within 6 months of onset
- Most common JIA subtype
- Classically involves the knees or ankles
- Preschool-aged girls

2) Polyarthritis

- 5 joints within 6 months of onset
- Classified on the basis of serologic test results:
- RF positive and RF negative

3) Systemic-onset JIA = Still Disease

- 10-20% of cases
- Males = females.
- These patients present with:
  - **Fever**
  - **Salmon colored rash**
  - **Lymphadenopathy**
  - **Hepatosplenomegaly.**
- Symmetric and polyarticular arthritis can develop within months to years following the initial presentation.



4) Enthesis Related Arthritis= ERA:

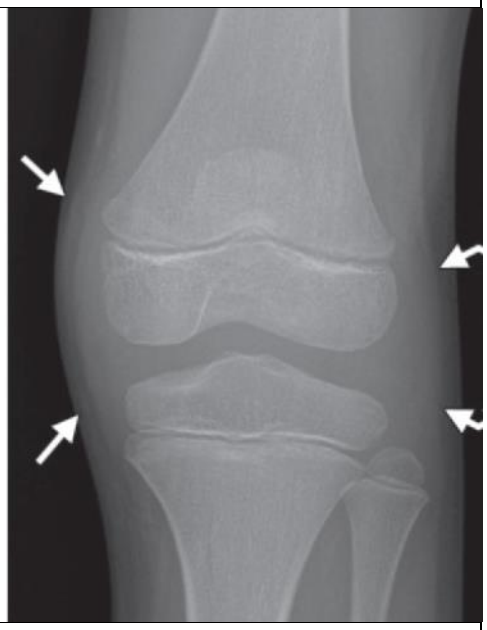
- Predominantly affects boys over 6 years of age
- Characterized by enthesitis, most commonly of the achilles tendon insertion, plantar fascia, and tarsus,
- Asymmetric arthritis of the lower extremities.
- Hip involvement is common at the time of presentation in era

5) Juvenile Psoriatic Arthritis

- like RF-negative polyarthritis, is heterogeneous in terms of presentation and prognosis
- Patients with psoriatic arthritis can have large or small joint involvement and may present with dactylitis before developing typical skin changes of psoriasis

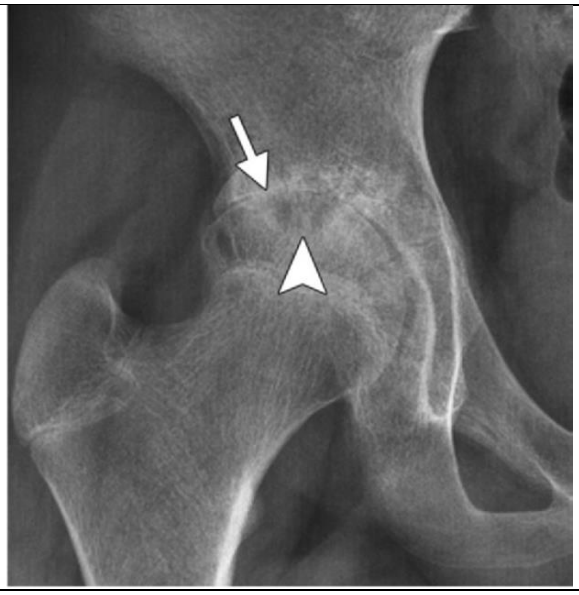
❖Early-Stage JIA

- Nonspecific.
- Soft-tissue swelling,
- Joint effusion
- Periarticular osteopenia



❖Progressive JIA

- Uniform joint space narrowing due to progressive, irreversible cartilage destruction.
- Small erosions



❖Advanced JIA

- Ankylosis.
- Growth disturbances.
- Joint malalignment.

Wrist:	**Cervical spine:**
Carpal bones ankylosis	**Apophyseal joints ankylosis**
Hand	**Large Joints**
Soft-tissue swelling Periarticular osteopenia. Joint space narrowing Erosions ensue,	Widened intercondylar notch Epiphyseal enlargement Squaring of the lower pole of patella Mimicking hemophilia

Role of MRI:

- Establish an early diagnosis of rheumatoid arthritis.
- Identify inflammation at the insertions of ligaments and tendons (enthesitis) that help differentiate rheumatoid arthritis from some clinical subsets of peripheral spondyloarthropathies.

MR Imaging Findings of Early Rheumatoid Arthritis:

- Joint space => Synovitis (Pannus) + Effusion + Narrowing
- Bone Marrow => Periarticular BM edema (Hyperemia) + Subchondral cysts + Erosions
- Tendons => Tenosynovitis + Tendinosis

Synovitis:

- T1 WI: Intermediate - low SI
- T2 WI: High SI
- STIR: more clearly delineates disease extent
- Very heavily T2 WI: can be helpful in identifying synovitis, which has a lower SI than does joint effusion.
- Contrast-enhanced T1 WI:
- Early phase: Acute synovitis enhance rapidly and intensely
- Delayed phase: Joint fluid enhancement occurs after > 10 min, reaches a plateau after 30 minutes, and persists for at least 1 hour; may be related to the diffusion of gadolinium into the synovial joint fluid.

Pannus

- T2/STIR: Synovial proliferation can be seen as hypointense frondlike material outlined by high-signal-intensity joint fluid.

Synovial Fluid:

T2/STIR: Hyperintesne signal
+C: NO enhancement.

Rice bodies

- Small fragments of the hypertrophic synovium may undergo fibrinoid necrosis and slough into the joint.

Tenosynovitis:

- T2/SIR: Increased fluid signal around the tendon
- +C: Abnormal enhancement.

Bone marrow edema;

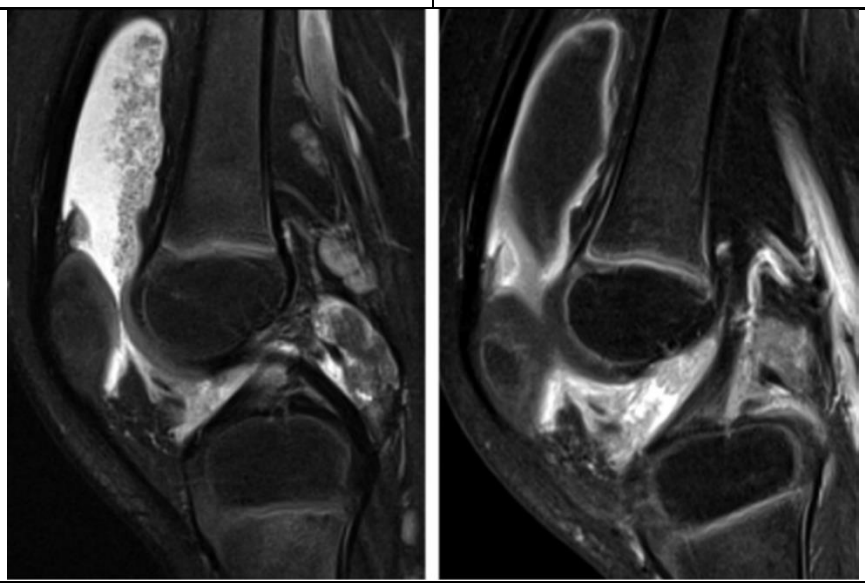
- Ill defined area, Low T1, High T2, patchy enhancement.

Synovitis + BM edema

STIR:	+C:
Synovitis (arrow) has lower signal than joint effusion (*) BM edema high signal (arrow head)	Synovitis: early nodular enhancement.

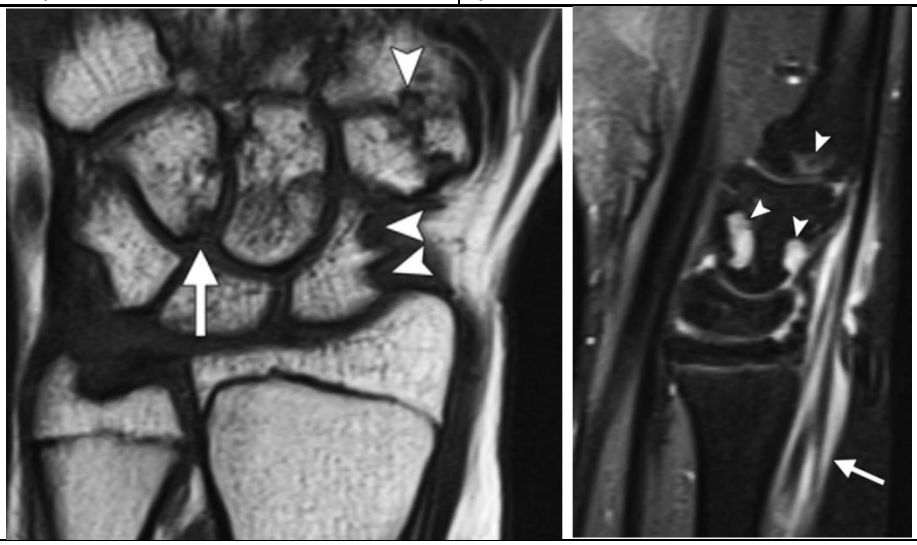
Rice Bodies:

Sagittal STIR: Large joint effusion with hypointense debris layering dependently within the effusion.	Sagittal T1+C FS: enhancing synovitis but no enhancement of the layering debris



Erosions:

Coronal T1 Erosion of the hamate bone (arrow) Erosions in the scaphoid bone and the base of the second metacarpal bone (arrowheads).	Sagittal T1+C FS Uniform enhancement of the erosions involving the capitate bone and the base of the third metacarpal bone (arrowheads

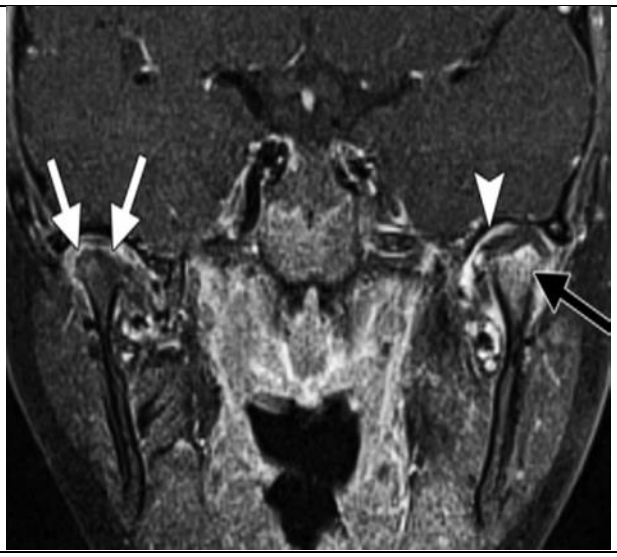


Sacroilitis:

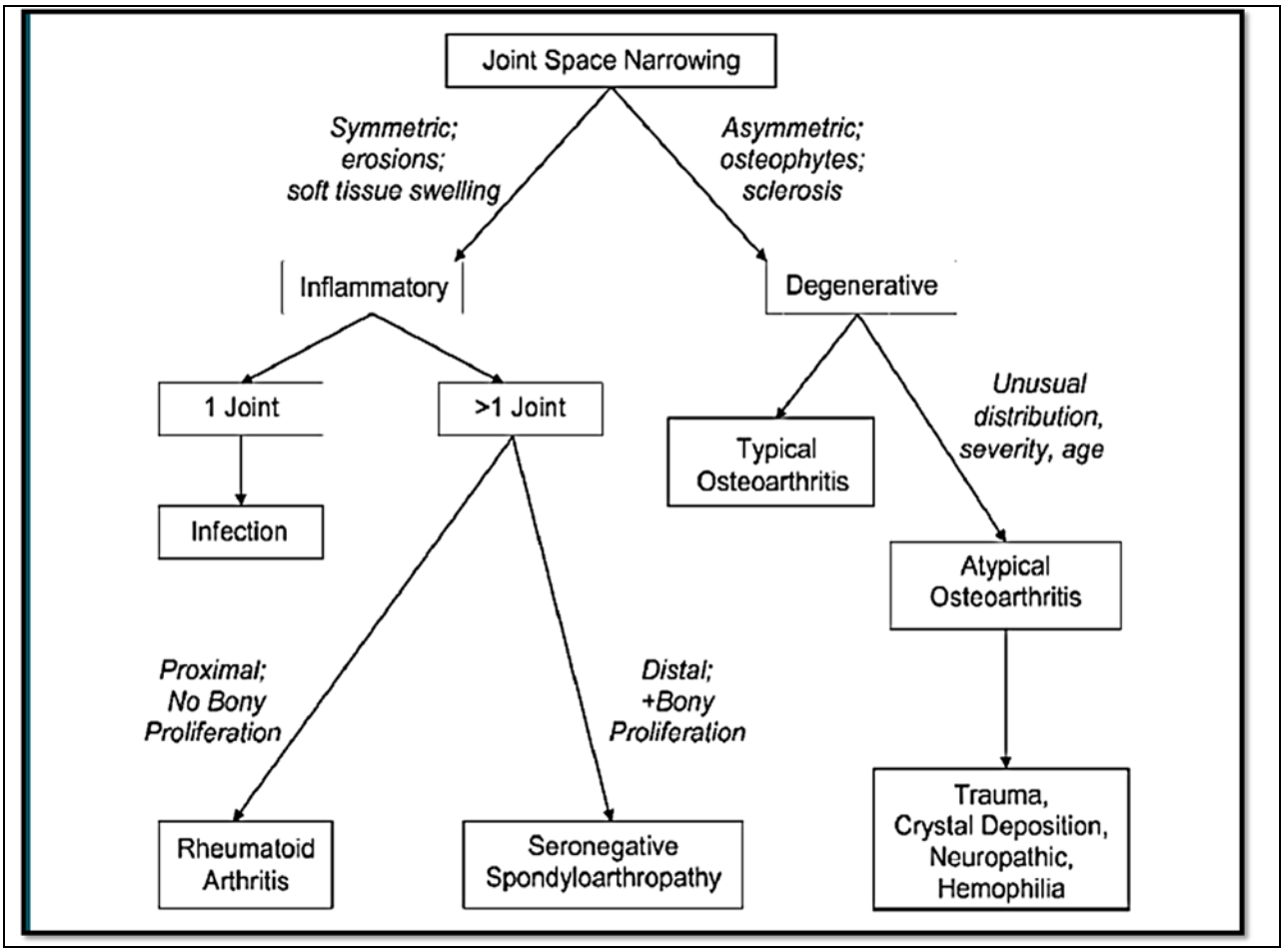
Coronal oblique contrast-enhanced fat-suppressed T1
The enhancement of these erosions (arrows) , the synovium,
and osteitis in the right iliac bone (arrowhead) is consistent with ongoing active inflammation

TMJ

- Coronal T1 +C FS
- Flattening of the mandibular condyle.
- Actively inflamed synovitis (arrowhead) and osteitis (black arrow) are also seen.
- Erosions of the right mandibular condyle (white arrows).



Algorithm for Arthritis ☺



III- Hypertrophic Arthritis

A. Degenerative Osteoarthritis:

- **1ry Osteoarthritis**
- **2ry Osteoarthritis**

B. Neuropathic Arthropathy

C. Deposition Arthritis:

- **Crystal deposition arthropathy:**
  - **Gout**
  - **Calcium pyrophosphate dihydrate deposition disease (CPPD)**
  - **Hydroxyapatite crystal deposition disease (HADD)**
    - **Milwaukee shoulder**
- **Amyloid arthropathy**
- **Haemophilic arthropathy**

A- Degenerative Osteoarthritis

- Degenerative joint disease is the most common arthritis.
- Articular cartilage damage => Subchondral bone
- Weight-bearing joints

Patho-physiology:

- Physical forces => ***destruction of cartilage*** => exposed subchondral bone => osseous changes.

1ry OA:

- No underlying local etiological factors
- Abnormal high mechanical forces on normal joint
- Age related (Wear and tear)

2ry OA:

- Obesity – Trauma – Infection – AVN
- Any arthritis can ends in OA: RA – CPPD – Hemophilia – Hemochromatosis

Radiographic Findings => ⑤:

- Joint space narrowing (asymmetrical – Weight bearing portion)
- Subchondral sclerosis
- Subchondral cyst (Geode cyst)
- Osteophytes
- Loose bodies

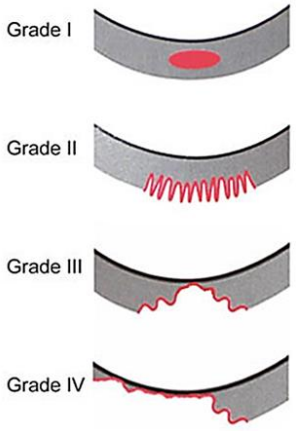
MRI Findings => ⑤:

- Cartilage damage
- Subchondral bone marrow edema-like lesion
- Subchondral cyst
- Osteophytes
- Meniscal Tears and Extrusion

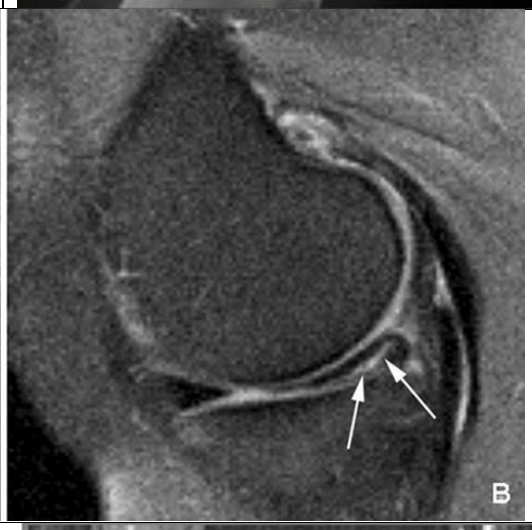
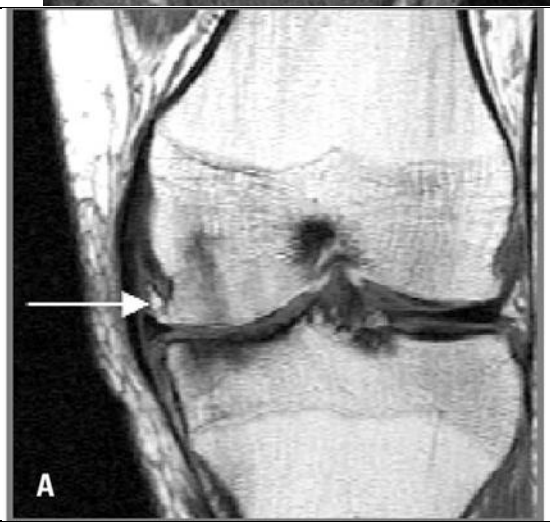
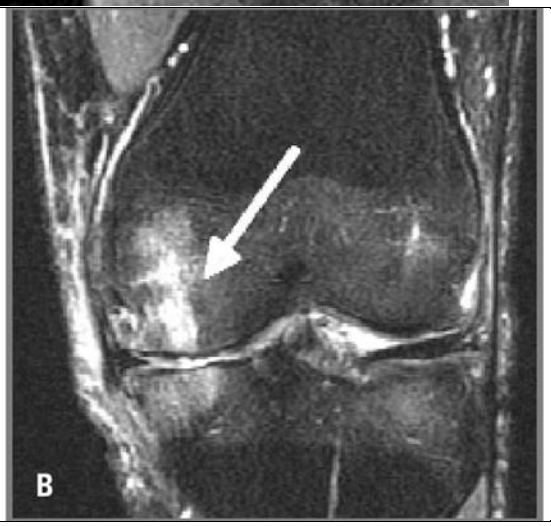
❖ **Outerbridge Classification of Cartilage injury**

Grade	MRI features	Arthroscopy
I	FS PD focal areas of hyperintensity within normal contour	Softening by arthroscopy
II	FS PD fissure or blister-like swelling of articular cartilage extending to surface	Fissuring and fibrillation within soft areas of articular cartilage (1-2 mm deep)
III	FS PD focal ulcerations and "crab meat" lesions	Partial thickness cartilage loss >2 mm deep
IV	FS PD full-thickness cartilage loss with underlying bone reactive changes	Ulceration with exposed subchondral bone

FS PD: Fat saturated Proton density

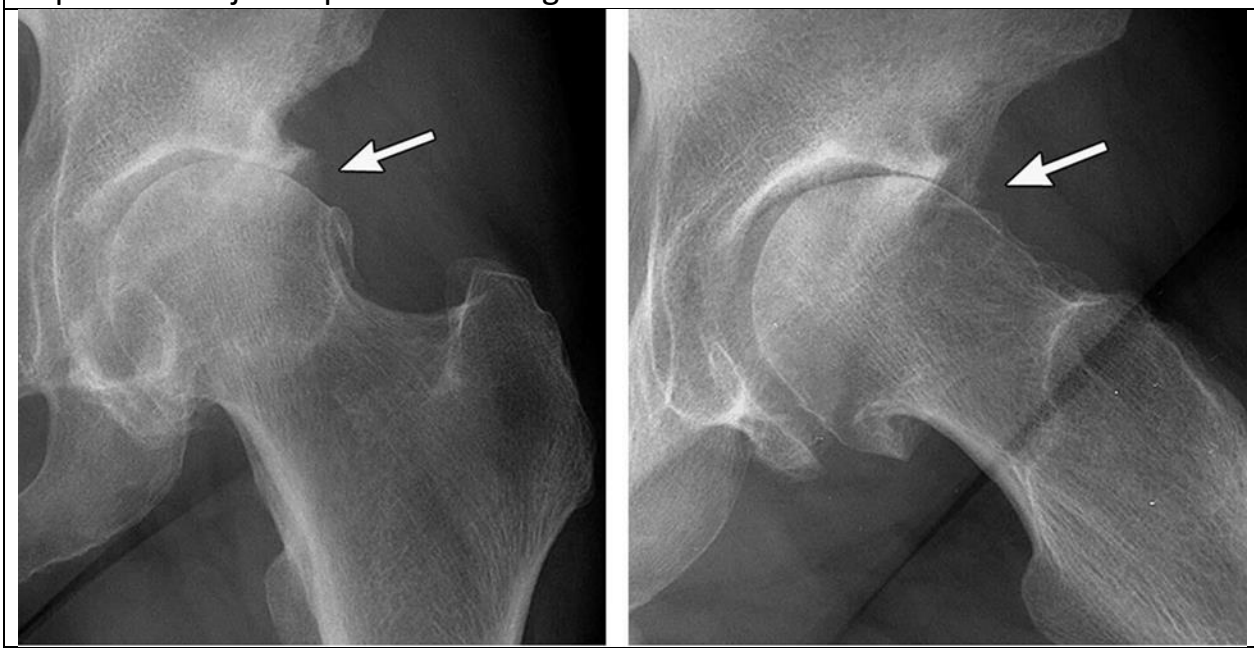


KNEE

Medial tibiofemoral joint space narrowing	Patellofemoral joint space narrowing Patellar tooth sign
	
	

HIPS

Superolateral joint space narrowing



Acromio-clavicular Joint

HAND

1st carpometacarpal joint – DIP – PIP

Hard bony enlargements:

Heberden's nodes (on DIPJ)

Bouchard's nodes (on PIPJ)

Scaphotrapeziotrapezoidal (STT or Triscaphe joint) OA

TMJ:

Osteoarthritis of the temporomandibular joint (TMJ) is the end point of long-standing TMJ dysfunction.

- Flattening: common (27%)
- Osteophytes: common (27%)
- Erosions: 13%
- Sclerosis: less common

Closed

Open

B- Neuropathic Arthropathy

Charcot Joint

- The term neuropathic arthropathy or Charcot joint is applied to all articular abnormalities related to central or peripheral neurologic lesions.

Predisposing Factors:

- Diabetes Mellitus
- Tabes Dorsalis
- Syringomyelia
- Meningomyelocele
- Multiple Sclerosis
- Trauma
- Alcoholism
- Amyloidosis

Pathogenesis

Loss of deep sensation and proprioception + Recurrent injury

Most Common Site:

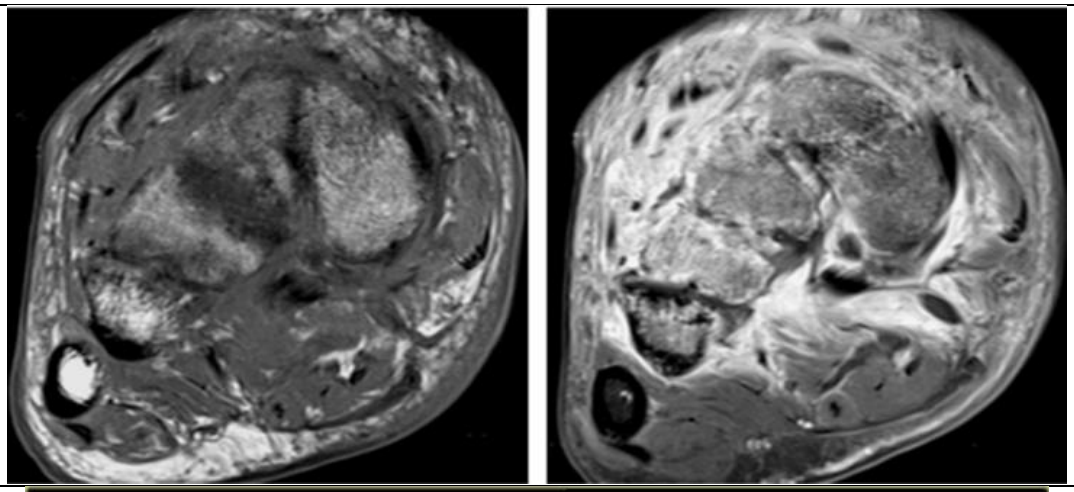
- Shoulder - Syringomyelia
- Hip – Syphilis and Spinal dysraphism
- Knee – Syphilis and Diabetes
- Foot midfoot (subtalar, intertarsal, and tarsometatarsal joints)– Diabetes
- Spine – Spinal dysraphism

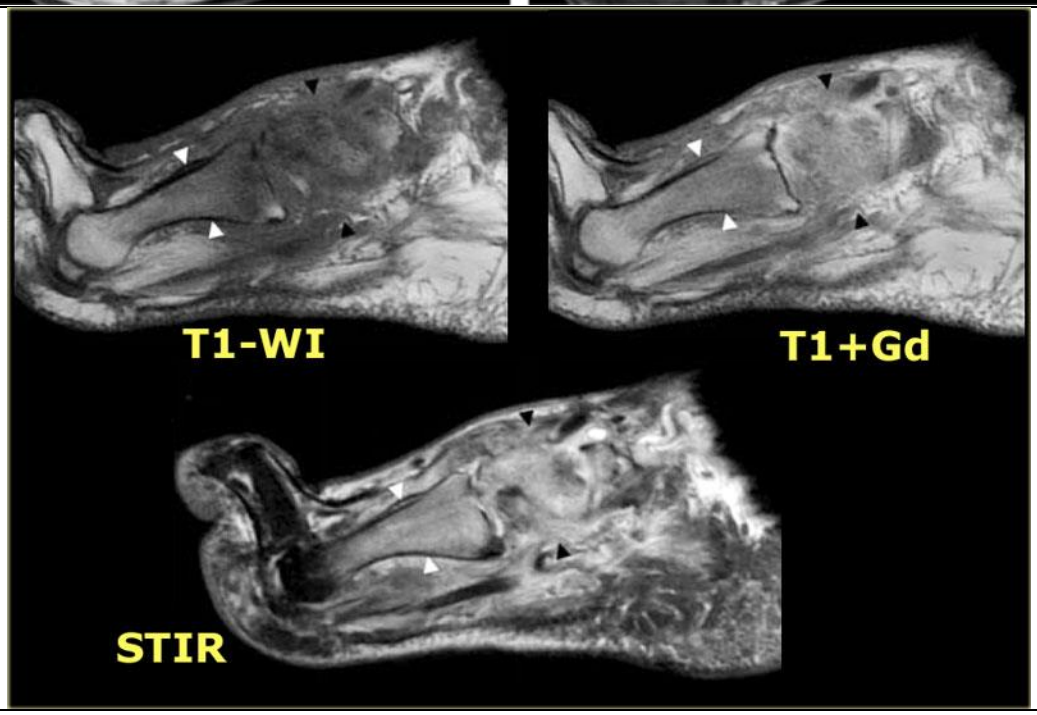
Acute Neuropathic Osteoarthropathy

- NO ulcer
- Soft tissue edema
- BM edema
- Subchondral cysts
- Subchondral erosions
- Joint effusion

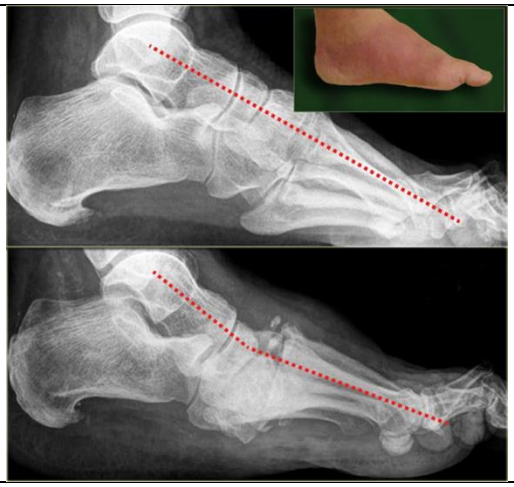
Chronic Neuropathic Osteoarthropathy (Charcot Joint) = 6Ds

- Distended joint = joint effusion
- Density increase = Bone sclerosis
- Debris production
- Destruction
- Dislocation = Lis-franc dislocation
- Deformity = Rocker-bottom deformity

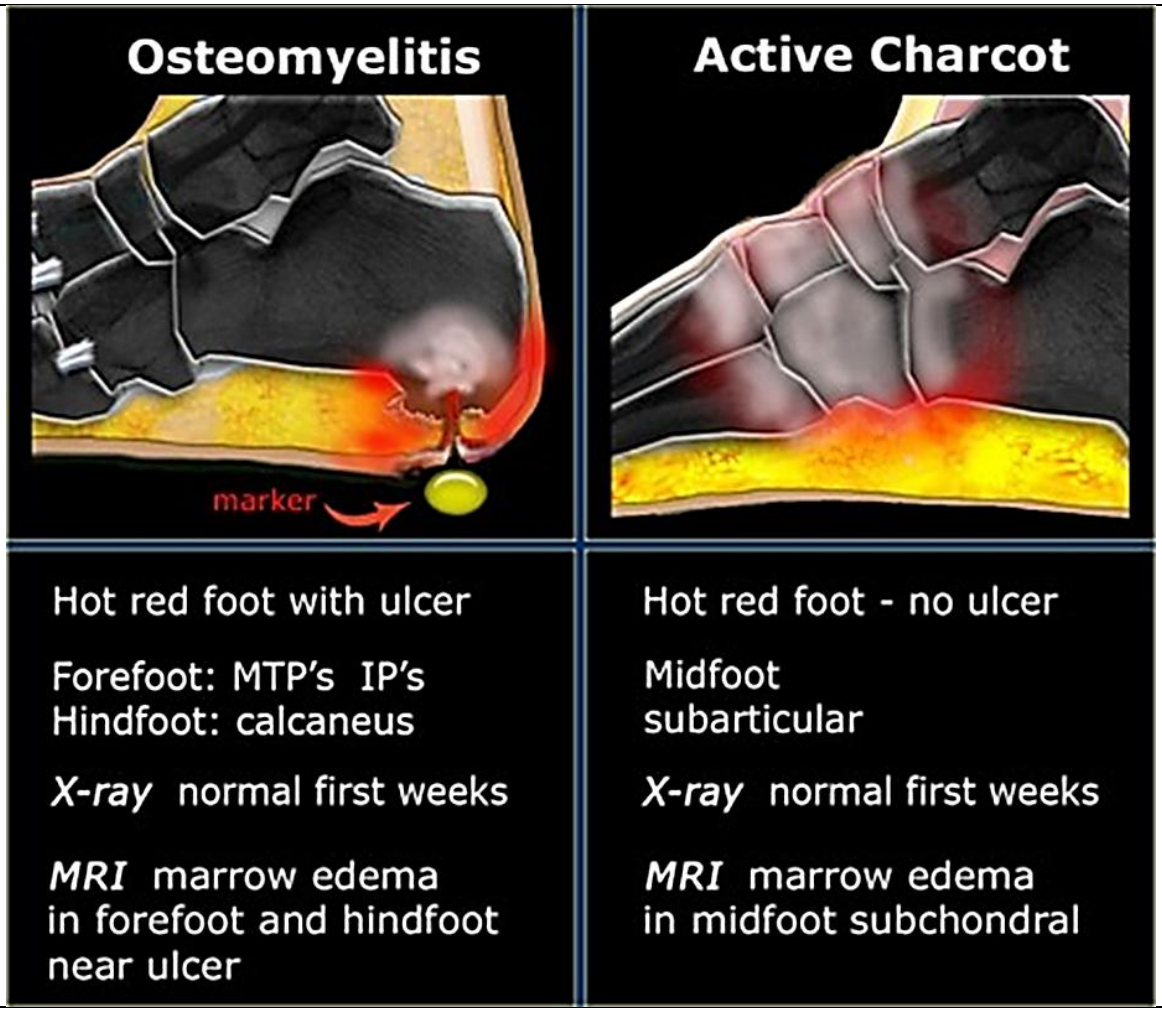




Rocker-bottom deformity



Lis-franc dislocation



Charcot arthroplasty of Knee

Charcot arthroplasty of Shoulder

C- Depositional Arthritis

1) Gout Arthritis

- Crystal arthropathy due to deposition of monosodium urate crystals in and around joints.
- Gout is a metabolic disorder characterized by hyperuricemia that arises from either an increase in production or a decrease in excretion of uric acid
- Age > 40y
- Sex: M>F

Location :

- 1st MTP joint most common
- Hands, wrists, elbows, and knees.

3 Stages Of Articular Manifestations:

i. **Acute gouty arthritis: (Clinical + Lab):**

- Mono/oligo articular
- Acute inflammatory arthritis
- Laboratory

ii. **Intermediate**

iii. **Chronic tophaceous gout:**

- Multiple attacks + Many years (10 – 12 years)

Radiographic Findings of Chronic Tophaceous Gout:

Erosions

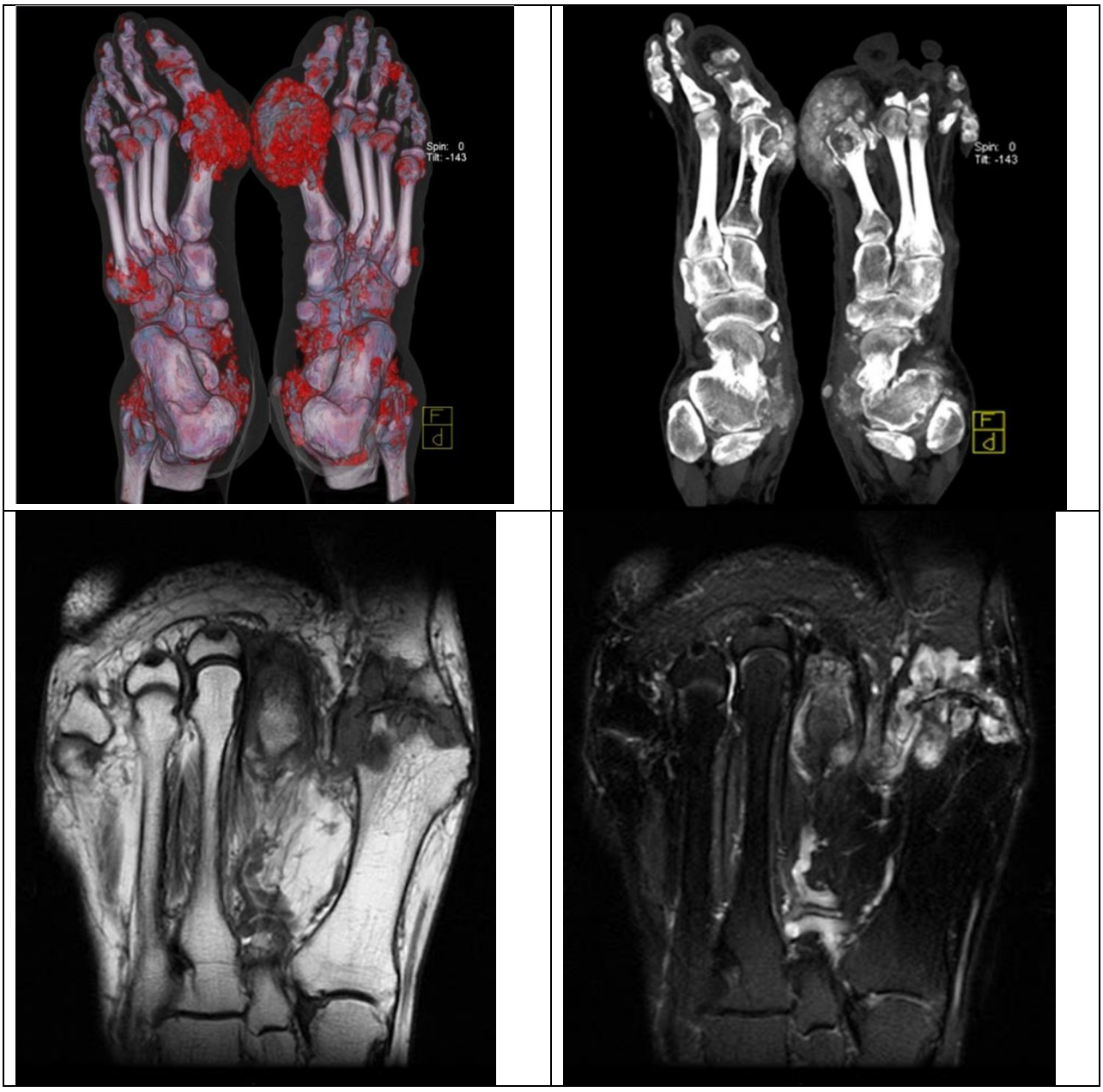
- Marginal = bare area
- Periarticular = metaphysis / diaphysis
- Intraosseous = well defined oval shaped radiolucencies intra medullary
- Well-defined “punched-out” erosions
- Overhanging edges
- Sclerotic margins
- Preserved joint space
- Normal mineralisation

Tophi

- Periarticular soft tissue swelling due to crystal deposition in tophi around the joints.
- Hyperdense due to the crystals
- Tophi can calcify
- Juxta-articular
- Olecranon and prepatellar bursitis
- T1 WI: Intermediate SI (Isointense relative to muscles)
- T2 WI: Intermediate to low SI
- Post contrast: Homogeneous and intense enhancement

Gout
Punched–Out Erosions
© Dr. Raj Carmona, 2014

Gout
Sclerotic Overhanging Edges
© Dr. Raj Carmona, 2014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d
Spin: 0
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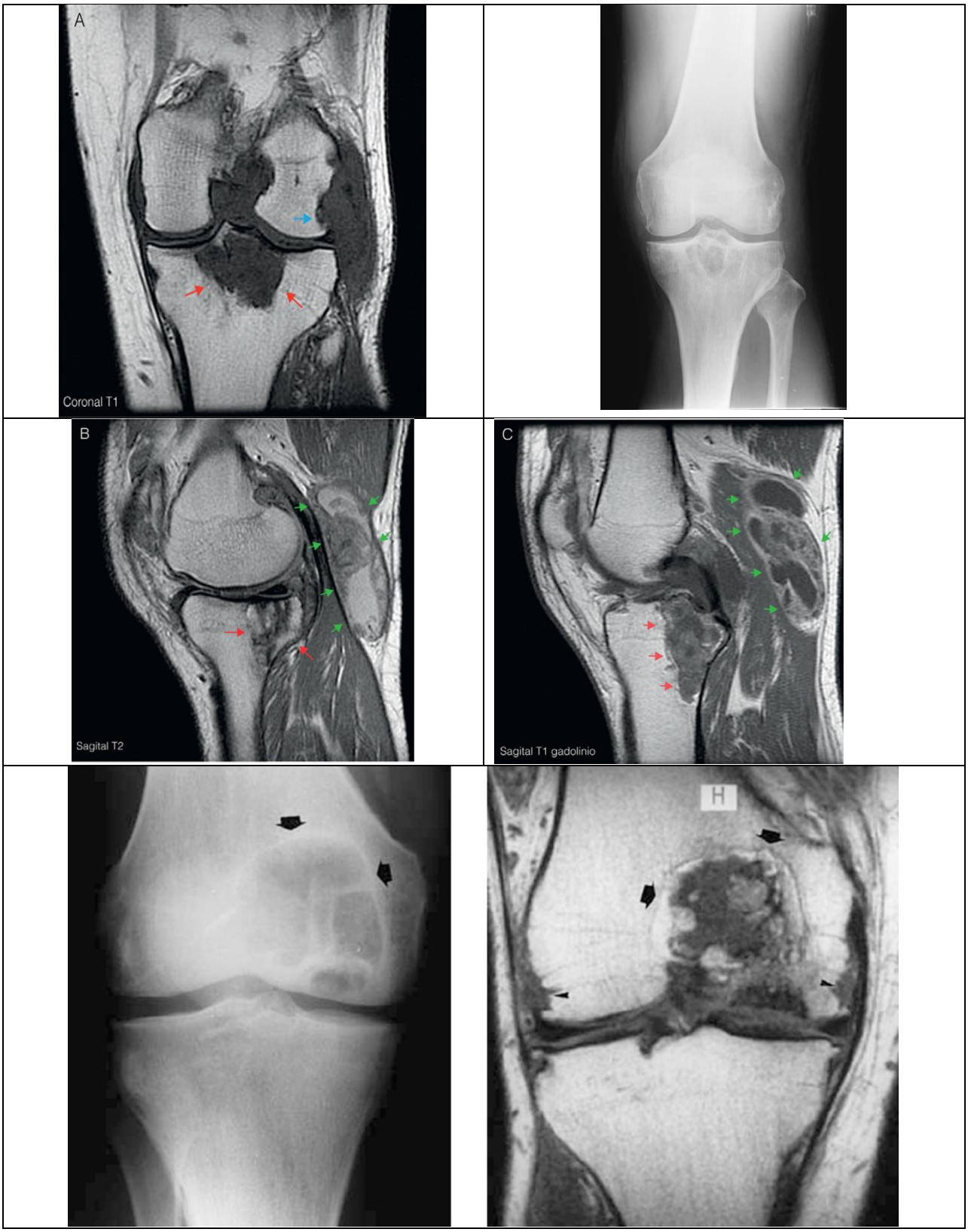

A
Coronal T1
B
Sagital T2
C
Sagital T1 gadolinio
H

2) CPPD Arthritis

- Calcium Pyrophosphate Dihydrate Crystal Deposition Disease.
- **Chondrocalcinosis:** calcification of hyaline (articular) cartilage or fibrocartilage (menisci) or ligaments
- **CPPD deposition**: Deposition of crystals in the joint with or without chondrocalcinosis
- **CPPP Arthropathy**: arthropathy secondary to CPPD
- **Pseudogout** is an older clinical term referring to acute pain (similar to gout) but without response to the usual treatment for gout

- Age: older population
- M:F = 3:2

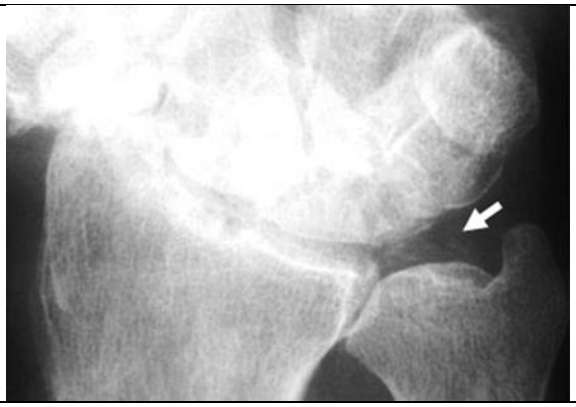
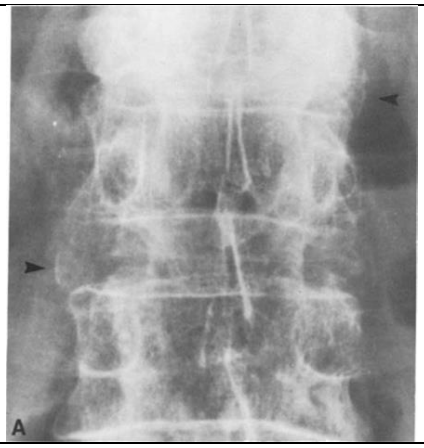
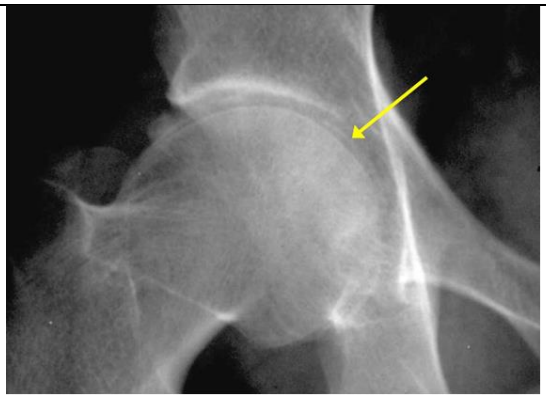
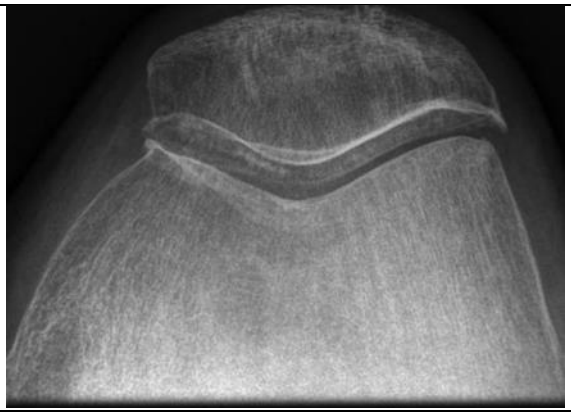
In association with metabolic diseases

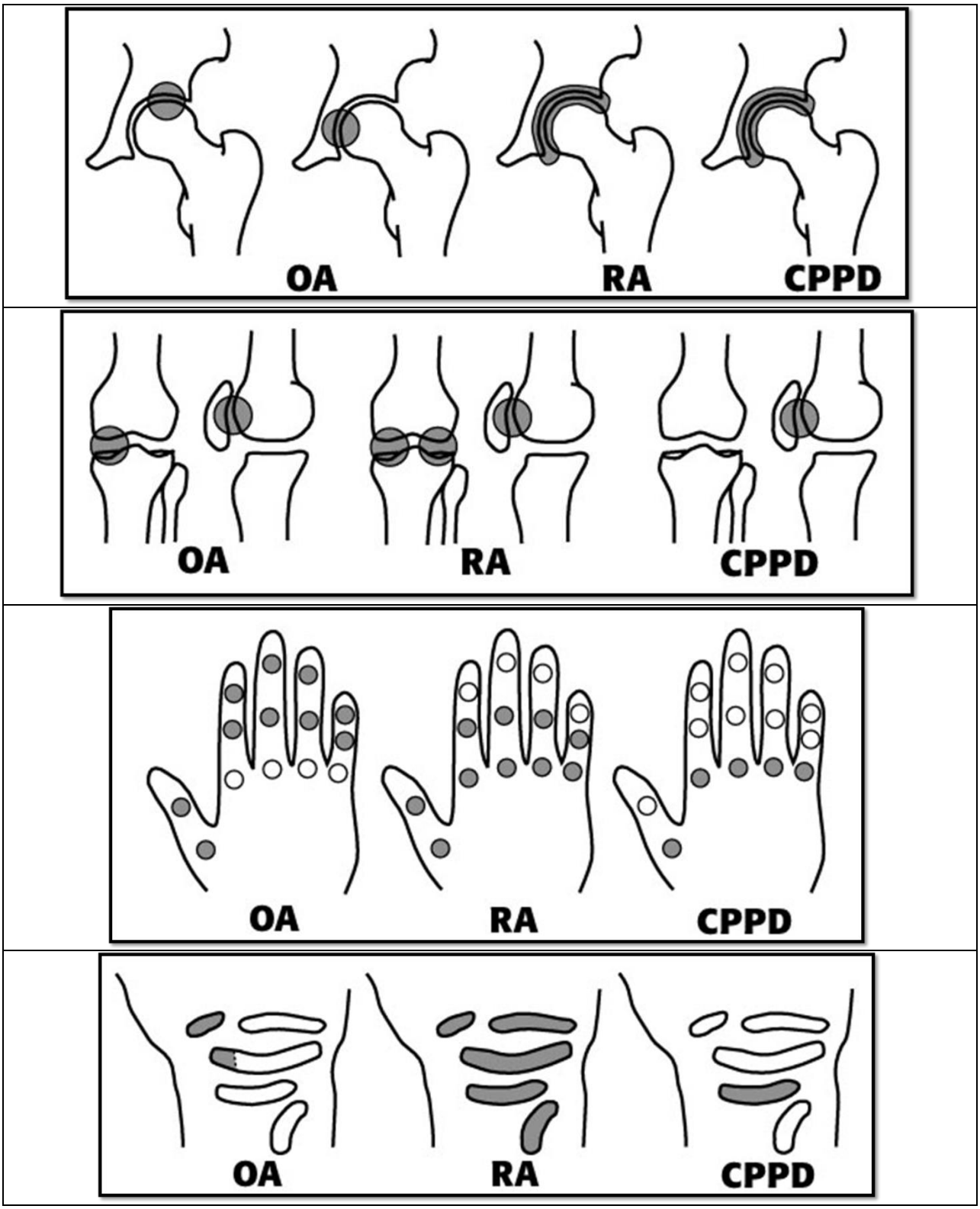
- Hyperparathyroidism
- Hemochromatosis
- Hypothyroidism
- Hypomagnesemia
- Hypophosphatasia
- Ochronosis

2 Main Radiographic Features:

- **Chondrocalcinosis**
- **Arthropathy resembling OA**

❖Chondrocalcinosis

Calcification of Menisci **Calcification of hyaline cartilage**	**Calcification of TFCL**
	
Calcification of discs	
	
Calcification of acetabulum labrum	
	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3) Hydroxyapatite Crystal Deposition Disease (HADD)

- Characterized by calcium phosphate (calcium hydroxyapatite) crystal deposition in the periarticular soft tissues, especially in the tendons (best recognised as **calcific tendinitis**).

Location:

Shoulder is the most frequently involved site with classic calcific tendinitis:

- **Supraspinatus tendon, adjacent to the greater tuberosity.**
- **Biceps tendon, adjacent to the glenoid tubercle.**

Supraspinatous calcific tendinosis	**Gluteus medius calcific tendinosis**

Milwaukee Shoulder

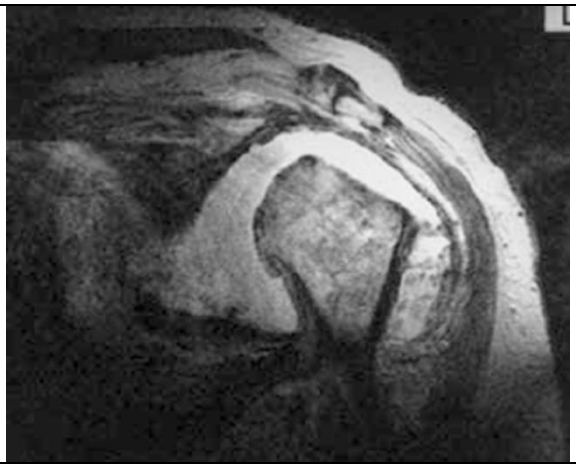
- Milwaukee shoulder refers to a destructive shoulder arthropathy due to deposition of hydroxyapatite crystals, and identification of these crystals in synovial fluid is the cornerstone of diagnosis.

Characterized by:

- Osteoarthritic changes
- Noninflammatory joint effusion containing Calcium hydroxyapatite and calcium pyrophosphate dihydrate crystals.

Radiographic findings:

- Joint space narrowing
- Subchondral sclerosis with cyst formation
- Destruction of subchondral bone
- Soft-tissue swelling
- Capsular calcifications
- Intraarticular loose bodies.
- Rotator cuff disruption
- superior subluxation of the humeral head in relation to the glenoid fossa



4) Hemochromatosis

- **Primary Hemochromatosis** is an inherited disorder where there is increase in total iron body stores.
- This leads to deposition of iron in parenchymal tissues, eventually causing functional impairment.
- M >>>> F
- Arthritic changes are seen in approximately half of the patients.

Secondary Hemochromatosis which can result from a variety of disorders:

- Frequent transfusion
- Haemolytic anaemia & myelodysplasia)
- Bantau siderosis : rare cause in Africa due to iron-laden locally brewed beer

Clinical picture:

- Hyper-pigmented skin "bronze" - 90%
- Hepatomegaly - 90%
- Arthralgia - 50%
- Diabetes - 30%
- Heart failure / arrhythmia - 15%

Distribution:

- **Hands**
  - Metacarpal heads, especially 2nd and 3rd MCP joints
  - Interphalangeal and carpal joints.

Radiographic Appearance: (as OA)

- Joint space narrowing
- Subchondral cysts
- Osteoporosis
- ***Hooked osteophytes = Radial beak-like osteophytosis at the radial ends of 2nd and 3rd metacarpal heads***
- ***Chondrocalcinosis (50% of the cases)***

5) Hemophilic Arthropathy

- Classic hemophilia (hemophilia A) and Christmas disease (hemophilia B) may be associated with repeated bleeding into the synovial joints and subsequent arthropathic changes.
- Age: 1st or 2nd decade of life

Most common sites:

- Knee, ankle, elbow, and shoulder.

MSK involvement in patients with hemophilia also includes:

- **Joints**: causes synovial hyperplasia, chronic inflammatory changes, fibrosis, and siderosis of the synovial membrane.
- **Muscles:** causes joint contractures or soft-tissue pseudotumors.
- **Bones:** Intra-osseous / subperiosteal hemorrhage = osseous pseudotumors

Radiographic Findings => Monoartcicular / Large Joints:

- Joint effusion (Hemoarthrosis)
- Juxta-articular Osteoporosis (Synovial inflammation and hyperemia)
- Chondral erosions and subchondral erosions and cysts
- Epiphyseal and metaphyseal overgrowth
- joint space narrowing (Cartilaginous denudation)
- Osseous proliferation (sclerosis and osteophytosis)
- Premature 2ry osteoarthritis

MRI:

Synovial thickening + Hemosiderin deposition: low signal on T1 and T2 with blooming on gradient echo sequences

knee

- Widened intercondylar notch
- Squared inferior margin of the patella
- Bulbous femoral condyles
- Flattened condylar surfaces

Elbow

- Enlarged radial head
- Widened trochlear notch

❖ KNEE

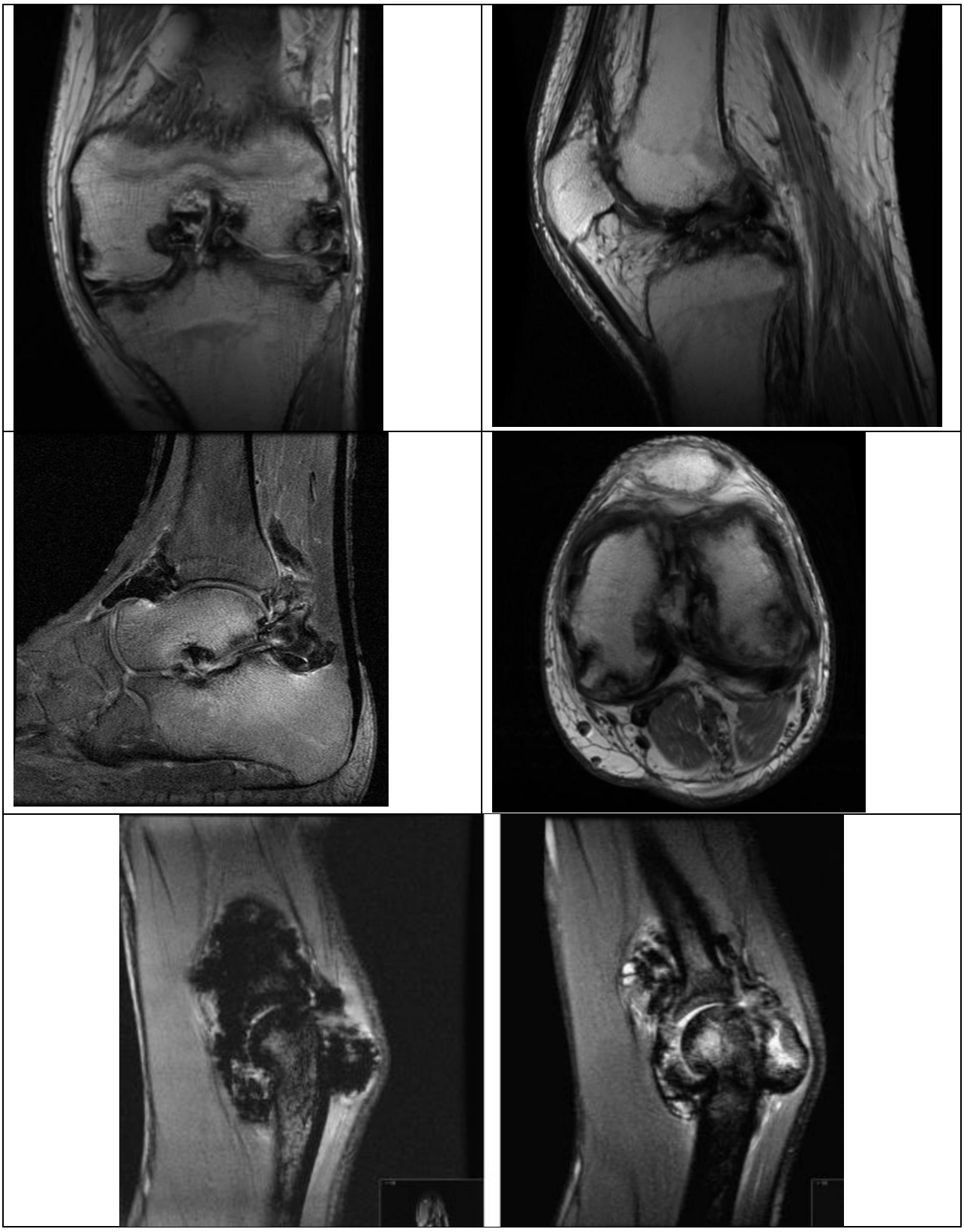
Early: Widened intercondylar nothch Epiphyseal overgrowth Flattened condylar surfaces	Squaring of patella Periarticular oseopenia Soft tisue swelling

Late: Premature 2ry osteoarthritis

❖ Elbow:

Enlarged radial head + Enlarged trochlear notch.
Increased soft-tissue density surrounding the joint (arrow) is due to synovial hemosiderin deposition.
Subchondral erosion and Cysts

2ry OA



Hemophilic Pseudotumor

6) Amyloid Arthroplasty

- Amyloid arthropathy is the extracellular deposition of the fibrous protein amyloid within the skeletal system.
- It is a skeletal manifestation of amyloidosis and may involve either the axial skeleton (especially the cervical spine) or the appendicular skeleton.
- Amyloid arthropathy is most commonly seen in:
    - Chronic hemodialysis
    - Plasma cell dyscrasia.

Clinical presentation

- Shoulder pain and carpal tunnel syndrome are the most common clinical manifestations

Location => Monoartcicular / Large Joints:

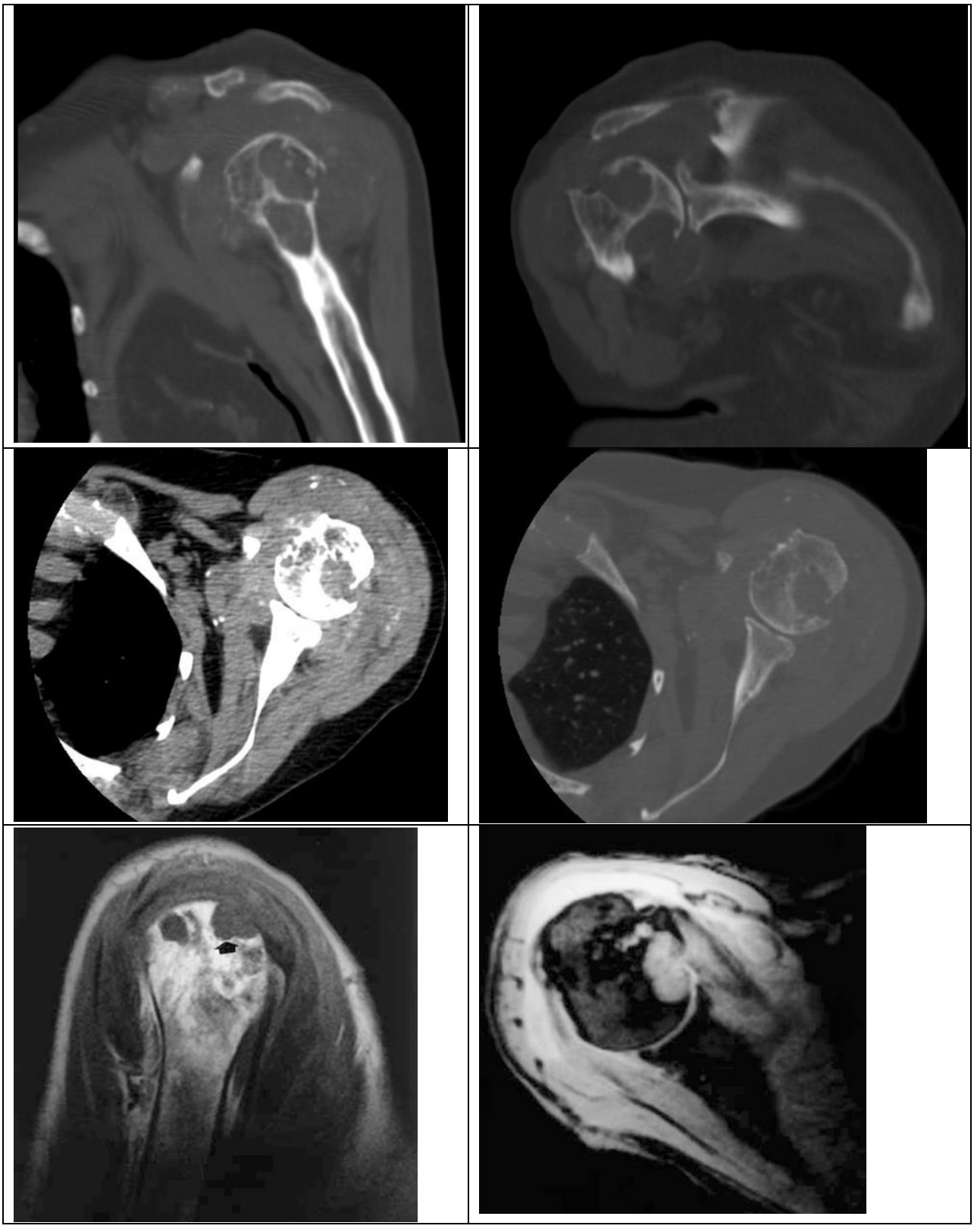
- Hips, shoulders and carpal bones

Radiographic Findings:

- Juxta-articular soft tissue swelling(s)
- Mild periarticular osteoporosis
- Subchondral cystic lesions, usually with well-defined sclerotic margins
- Preserved Joint space until late in the course of the disease

MRI:

Synovial thickening + deposition of an abnormal soft tissue with low signal on all MRI sequences



Intra-Articular Masses

- **Noninfectious synovial proliferative processes:**
  - **Lipoma Arborescens**
  - **Synovial Osteochondromatosis**
  - **PVNS**
  - **Rheumatoid Arthritis**

- **Infectious granulomatous diseases:**
  - **Tuberculous arthritis**
  - **Coccidioidomycosis arthritis**

- **Deposition diseases:**
  - **Gout**
  - **CPPD arthritis**
  - **HADD arthritis**
  - **Amyloid arthropathy**
  - **Haemophilic arthropathy**

- **Vascular malformations**
  - **Synovial hemangioma**
  - **Arteriovenous malformations**

- **Malignancies**
  - **Synovial Chondrosarcoma**
  - **Synovial Sarcoma**
  - **Synovial Metastases**

- **Miscellaneous:**
  - **Cyclops lesion**

1) Lipoma Arborescens

- Lipoma arborescens is a rare intraarticular lesion characterized by the replacement of the subsynovial tissue by mature fat cells, giving rise to a villous synovial proliferation.

Most common site:

- ***knee***, particularly in the suprapatellar pouch.

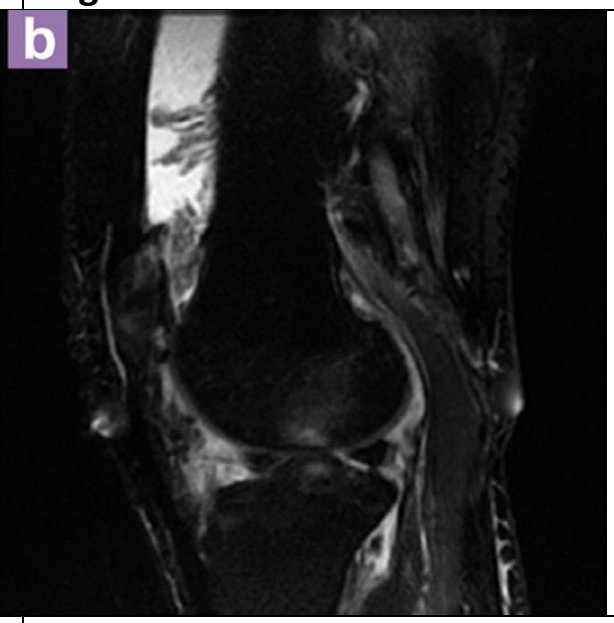
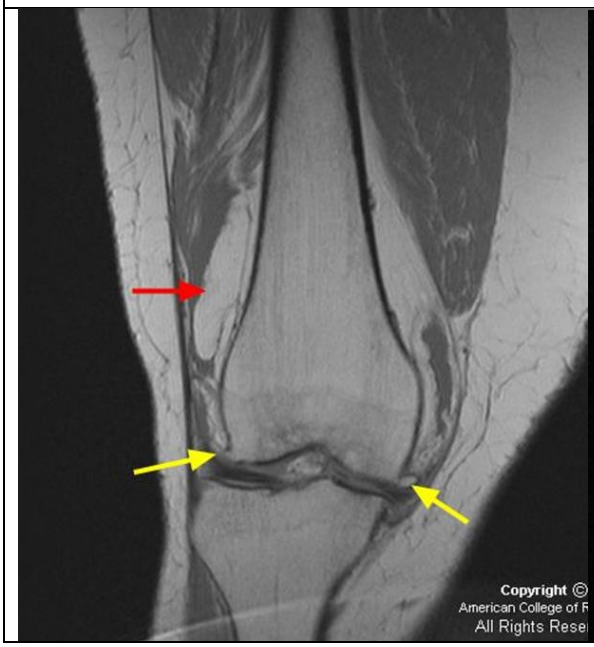
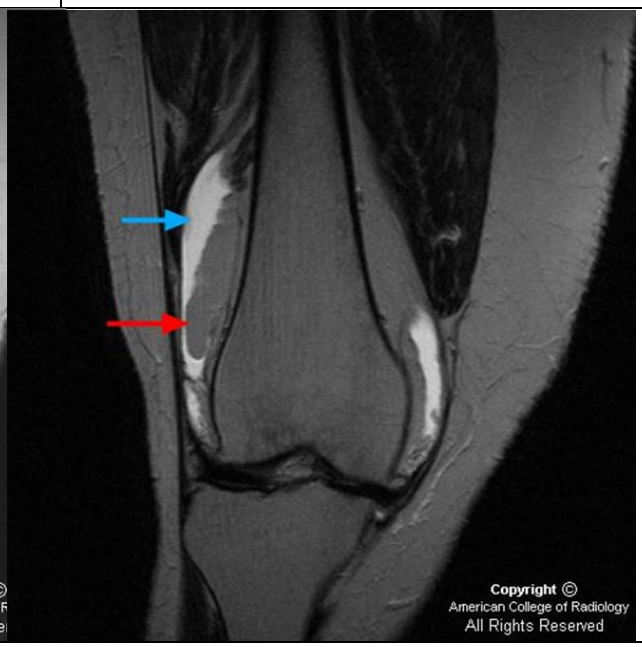
MRI

- frondlike projection in the suprapatellar pouch
- T1 and fat-suppressed sequences are used.
- The lesion has fat signal intensity with all pulse sequences.

Plain X-ray: Lateral View

Fullness of the suprapatellar bursa

Radiolucent areas (arrow) suggestive of fat.

Sagittal T1	Sagittal STIR
	
Coronal T1	**Coronal T2**
	

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2) Pigmented Villonodular Synovitis PVNS

- PVNS is a benign proliferative disorder of the synovium that may affect the joints, bursae, or tendon sheaths.
- Characterized by villous, nodular, and villonodular proliferation and pigmentation from hemosiderin.
- Young to middle aged adults.

Most common site: Monoarticular/large joint:

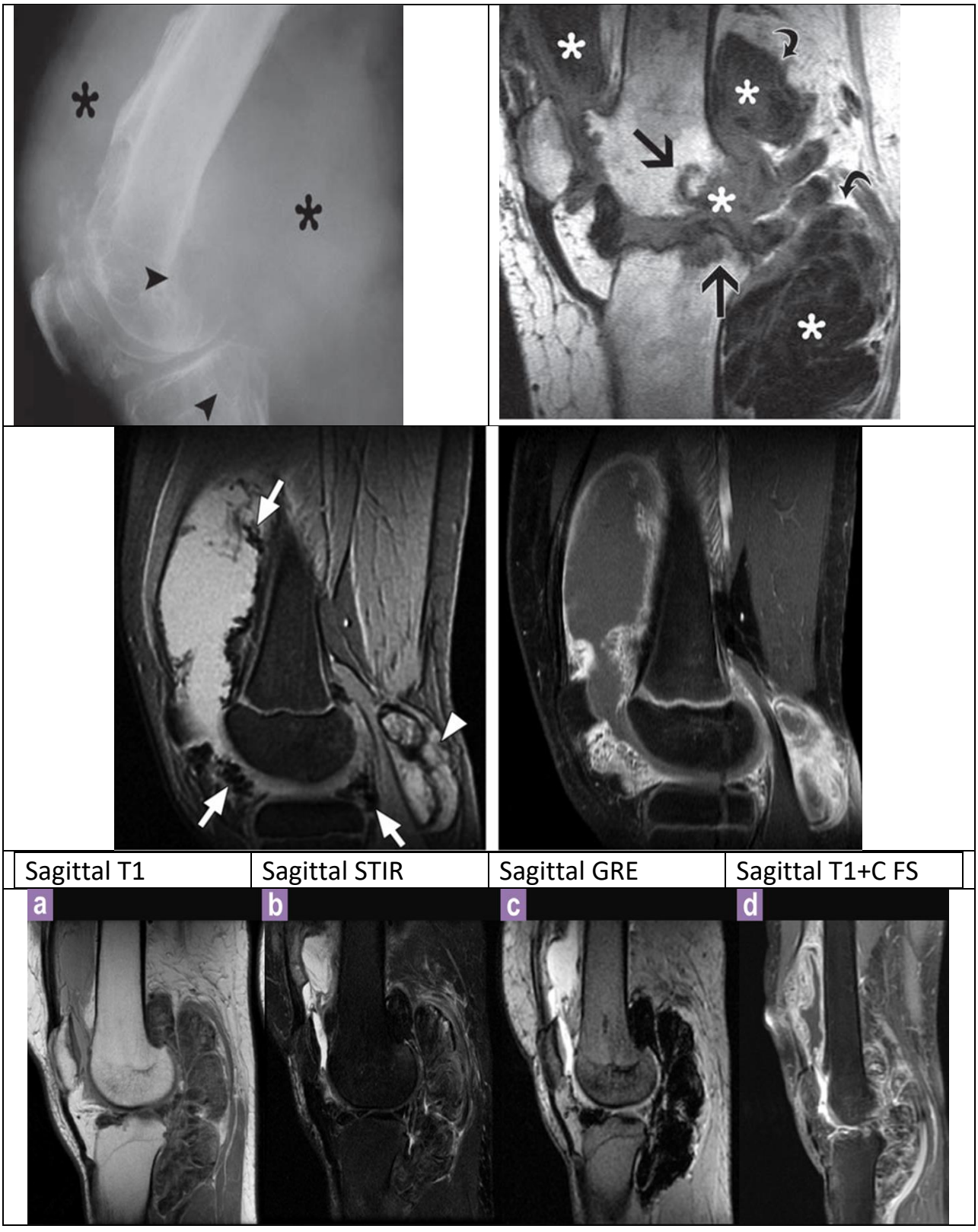
- The knee is the most frequently involved joint,
- Followed by the hip, ankle, and shoulder

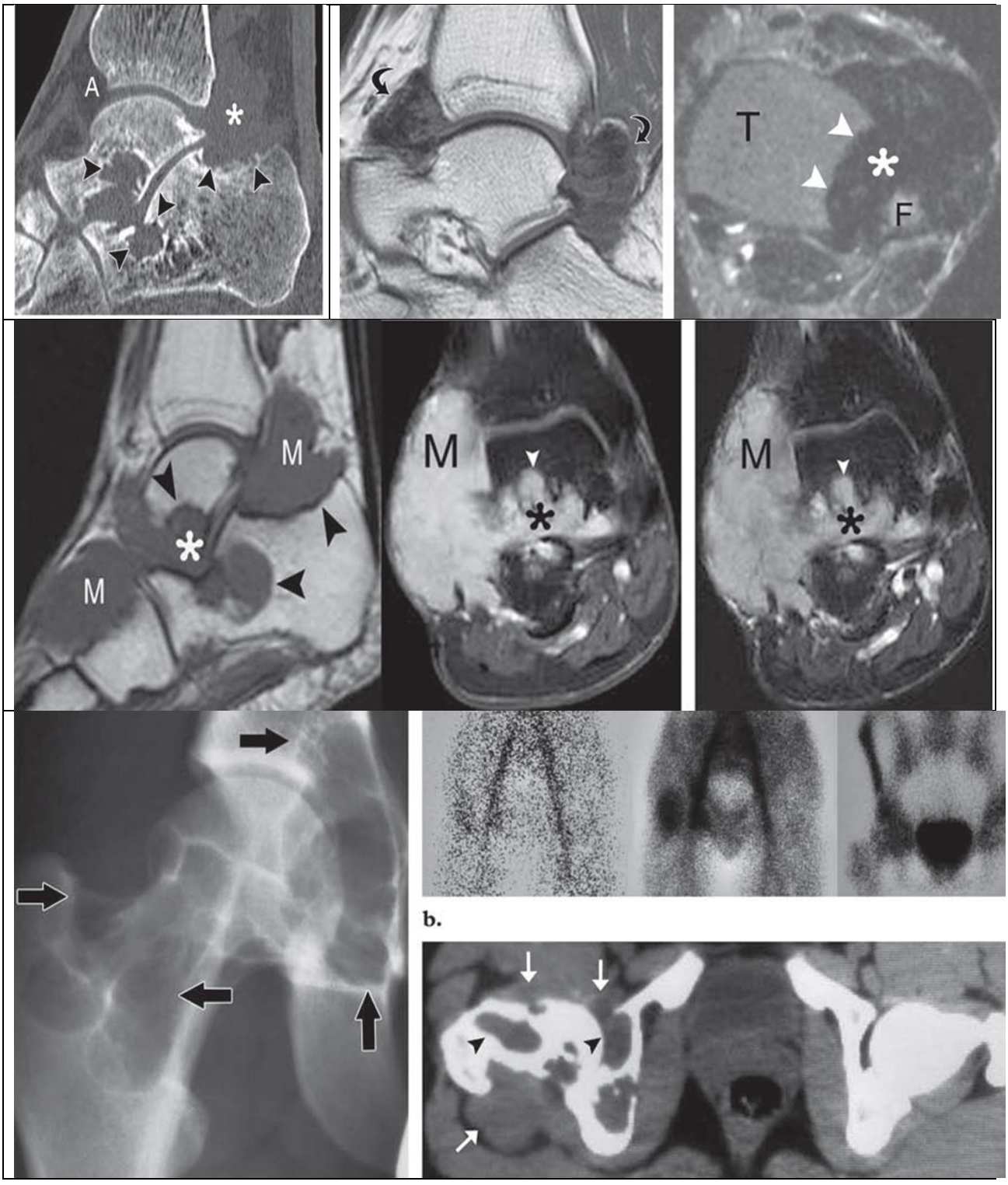
Types:

- Diffuse intra-articular PVNS
- Localized intra-articular PVNS
- Localized extra-articular:
  - Bursa (Pigmented villonodular bursitis = PVNB)
  - Tendon sheath (pigmented villonodular tenosynovitis = PVNTS) = Giant cell tumor of the tendon sheath (GCTTS) (Most Common)

A) Diffuse intraarticular PNNS

- Synovial-based diffuse extensive mass with lobulated margin
- T2/STIR:
  - Areas of intermediate - high signal (due to Inflamed synovium)
  - Areas of low signal (due to hemosiderin deposition)
- GRE: Blooming (due to hemosiderin deposition)
- T1 +C FS: marked enhancement (due to hypervascular inflamed synovium)
- Bone erosion or subchondral cyst: arise from cartilaginous defects (created by the underlying synovial process), with subsequent fluid extension.


Sagittal T1
Sagittal STIR
Sagittal GRE
Sagittal T1+C FS
a
b
c
d


A
T
F
M
M
M
M
b.

B) Localized intraarticular PVNS

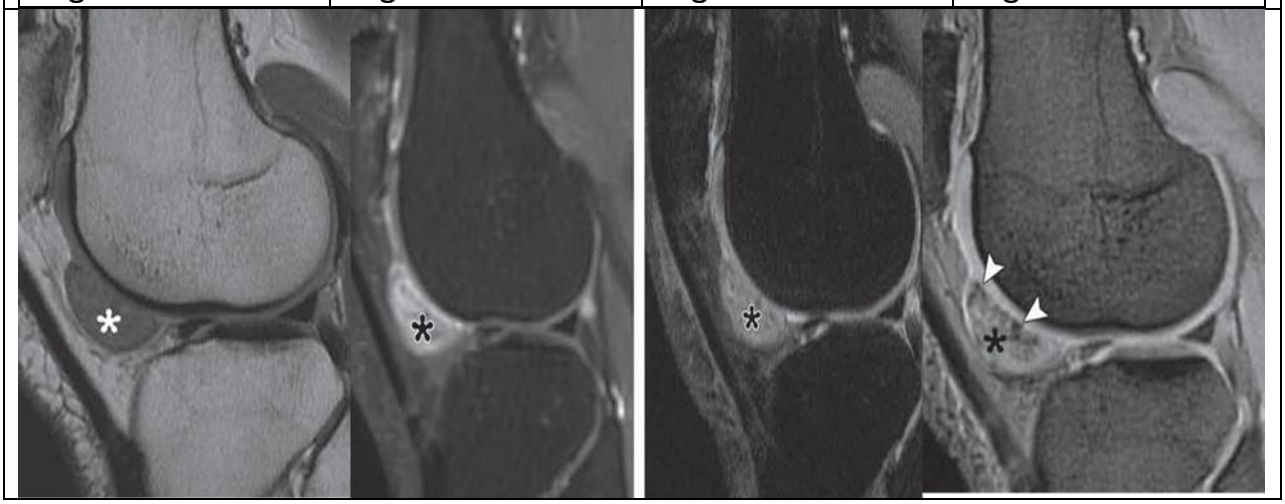
Localized intraarticular PVNS almost exclusively involves the knee

- ✓ **67% Infrapatellar in location**
- ✓ **24% Suprapatellar**
- ✓ **10% Posterior intercondylar.**

- T2/STIR:
  - Areas of intermediate - high signal (due to Inflamed synovium)
  - Areas of low signal (due to hemosiderin deposition)
- GRE: Blooming (due to hemosiderin deposition)
- T1 +C FS: marked enhancement (due to hypervascular inflamed synovium)

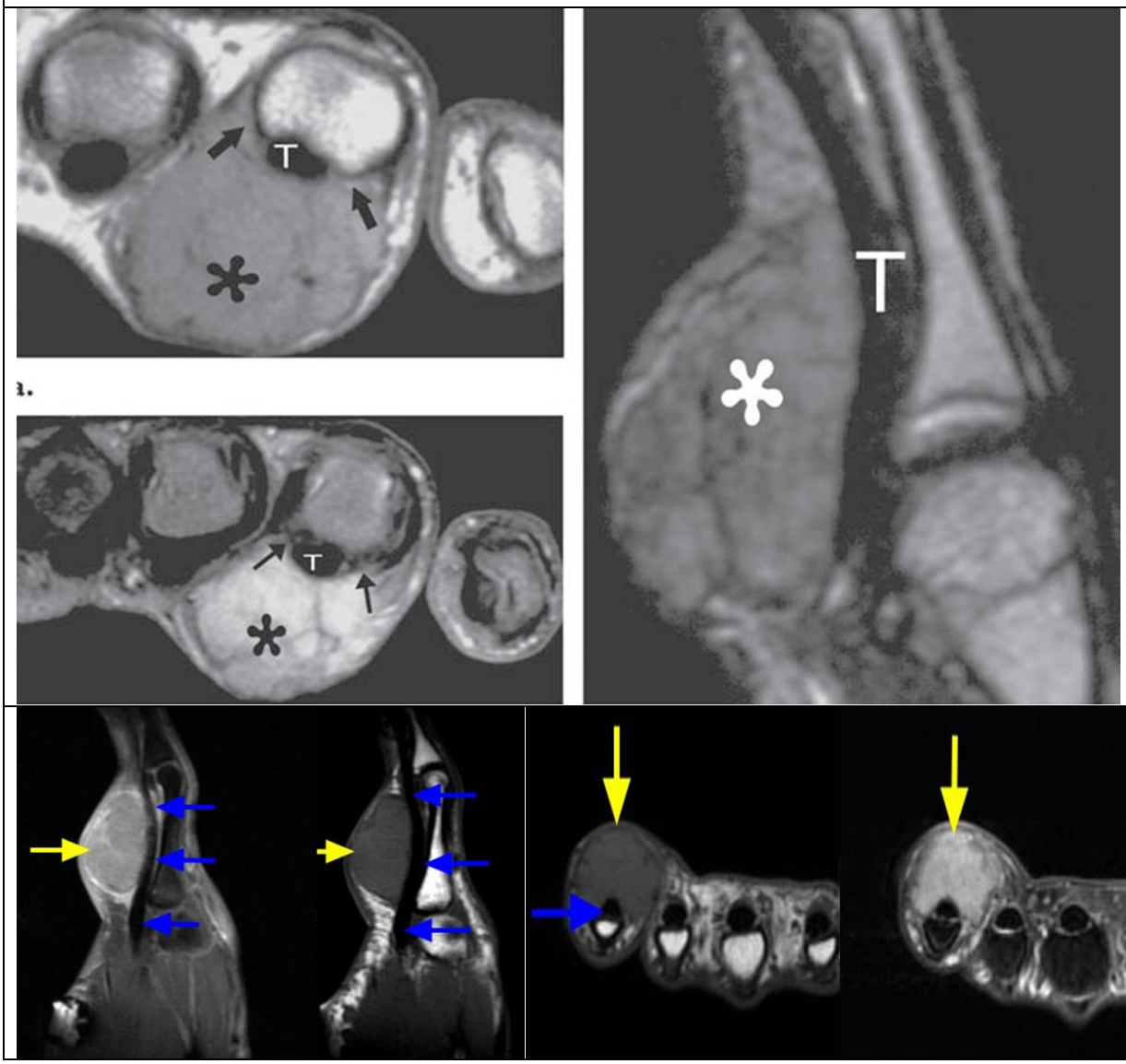
Lateral Xray	Sagittal PD	Sagittal T2

Sagittal PD	Sagittal T1 +C FS	Sagittal PD FS	Sagittal GE



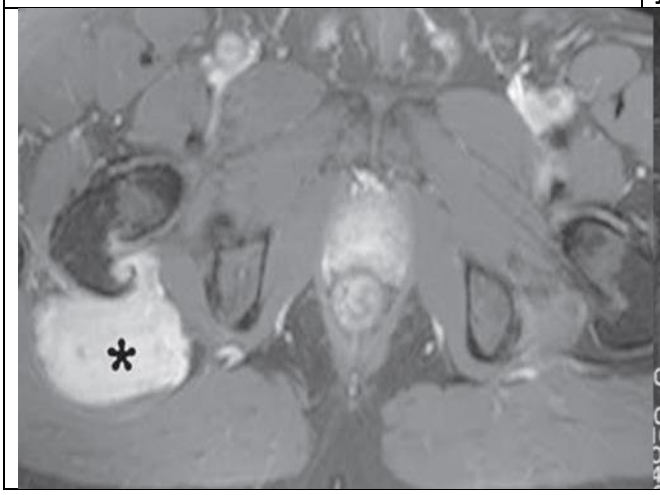
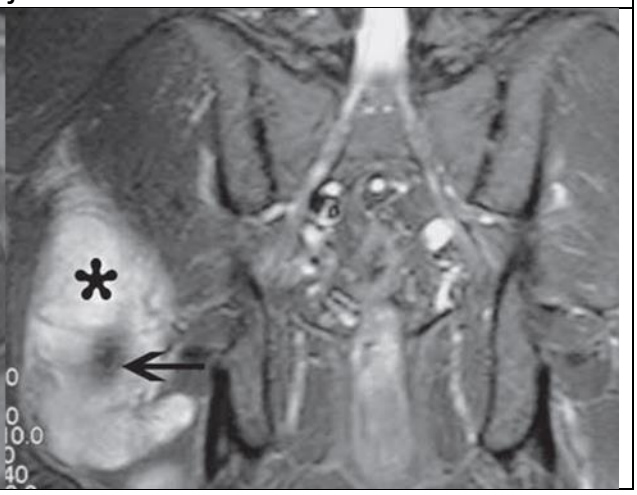
C) Giant Cell Tumor Of The Tendon Sheath (GCTTS)

- It most commonly affects joints in the hand and occurs on the volar (palmar) surface near the distal interphalangeal joint.
- 2nd most common mass of the hand (1st = ganglion).
- A well-circumscribed, soft-tissue mass adjacent to the involved tendon.
- Small extensions about the tendon margin are seen in most cases and suggest a tenosynovial origin. These extensions may entirely encase the tendon.
- T1 & T2: Low to intermediate signal intensity
- +C: contrast enhancement



D) Pigmented Villonodular Bursitis = PVNB

The bursal form of extraarticular disease, PVNB, is more similar to diffuse intraarticular PVNS

PVNB of the Greater Trochanteric Bursa	
Axial T1 +C FS: prominent diffuse enhancement	Coronal STIR : intermediate to high signal intensity in the mass (*), which surrounds the greater trochanter (arrow). There is no evidence of hip joint involvement.
	

3) Synovial Osteochondromatosis

- Benign
- Characterized by proliferation and metaplastic transformation of the synovium with formation of multiple cartilaginous nodules.
- Malignant transformation to chondrosarcoma is unusual (5% of cases)
- Middle age
- M > F

Location => Monarticular

- Knee (Most common)
- Elbow, hip, and shoulder.

Milgram 3 Phases:

- 1st phase: there is active intrasynovial disease, with the formation of cartilaginous masses within the synovium but no intraarticular loose bodies.
- 2nd phase: both intrasynovial osteochondral nodules, as well as intraarticular osteochondral bodies lying free within the joint cavity.
- 3rd phase: there is intraarticular free osteochondral bodies without active synovial disease.

Cartilaginous bodies may contain cartilage alone, cartilage and bone, or mature bone with fatty marrow.

Types:

- **Primary synovial chondromatosis:** was originally considered to represent chondroid metaplasia in the synovium of a joint with resultant formation of multiple intraarticular chondral bodies.
- **Secondary synovial chondromatosis:** is associated with joint abnormalities, such as mechanical or arthritic conditions, that cause intraarticular chondral bodies.
- Patients with secondary synovial chondromatosis are generally older than those with primary disease

❖ Radiographic Findings Of Primary Synovial Osteochondromatosis

- Pathognomonic in 70 – 95%
- Multiple Intraarticular Calcified/Ossified Nodules
- Characteristically uniform in size and shape
- Typical "ring-and-arc" chondroid mineralization.
- Target appearance may also be seen, consisting of a central focus of calcification and a single peripheral rim of calcification.
- Calcified nodules conglomerate together to form large amorphously mineralized juxta-articular mass.
- A small joint effusion
- Marginal erosions of opposing articular surfaces (Bubbly appearance).
- Late secondary degenerative joint disease.

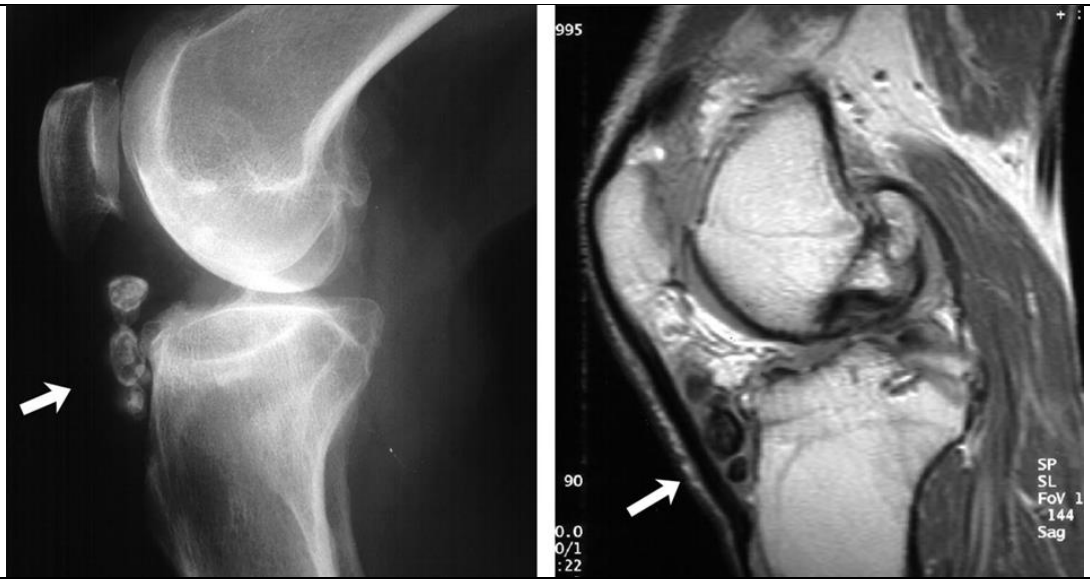
❖ Radiographic Findings Of Secondary Synovial Osteochondromatosis

- also reveals osteochondral intraarticular fragments;
- Fewer in number
- More variable in size (suggesting various times of origin),
- Several rings of calcification may be identified on radiographs, compared with the single ring seen in primary disease
- associated with the underlying joint abnormality (most commonly, osteoarthritis) are also apparent and allow secondary disease to be distinguished from primary synovial chondromatosis

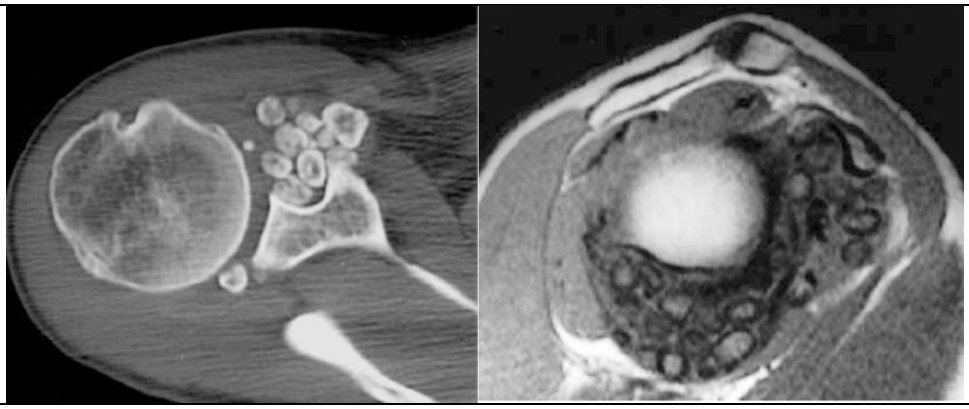
❖MRI (3 Patterns):

- **Calcified Nodules =** Isointense T1 WI and hyperintense on T2 WI and focal areas of signal void with all pulse sequences (corresponded to regions of calcification on radiographs or CT scans and became more conspicuous on gradient-echo MR images owing to magnetic susceptibility effects)
- **Synovial Proliferation =** Isointense T1 WI and hyperintense on T2 WI and no focal areas of signal void and no calcifications were seen on corresponding radiographs or CT scans
- **Ossified Nodules =** Intraarticular bodies with mature bone and fatty marrow display low SI of cortical bone peripherally and high SI of bone marrow fat centrally on T1 WI

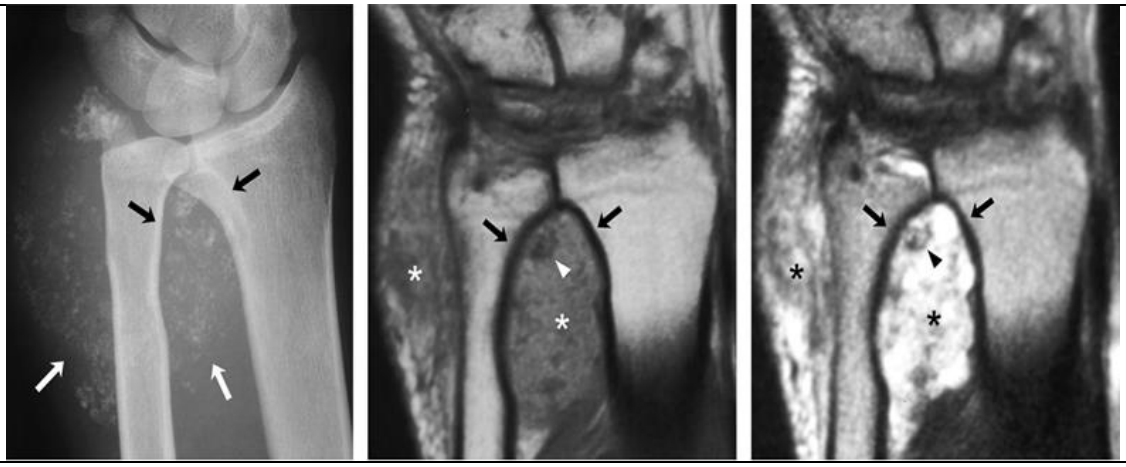
KNEE



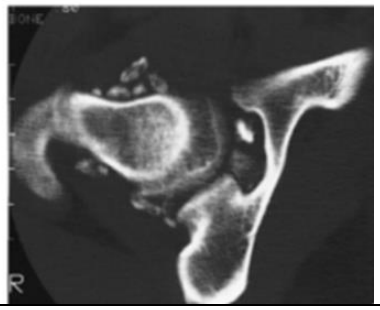
SHOULDER



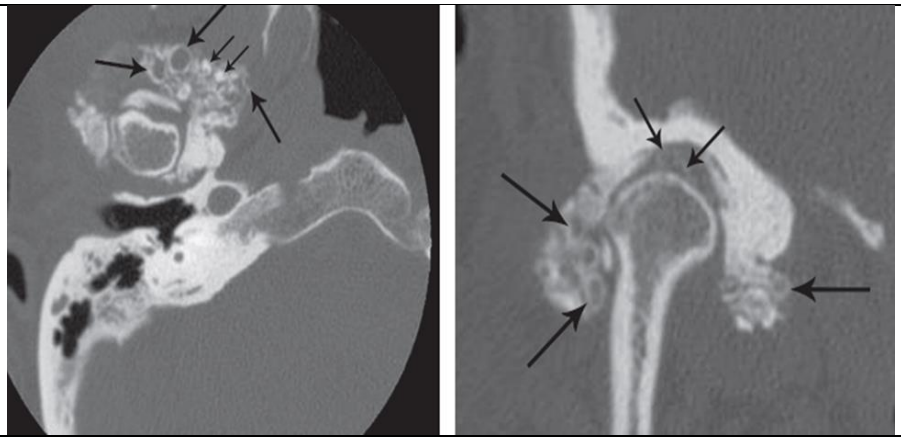
WRIST



HIP => Femoral Neck Apple Core sign

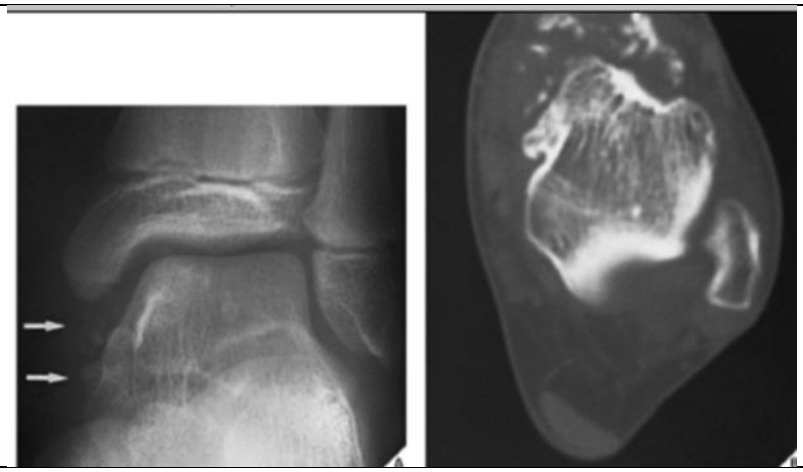


TMJ



ELBOW

ANKLE

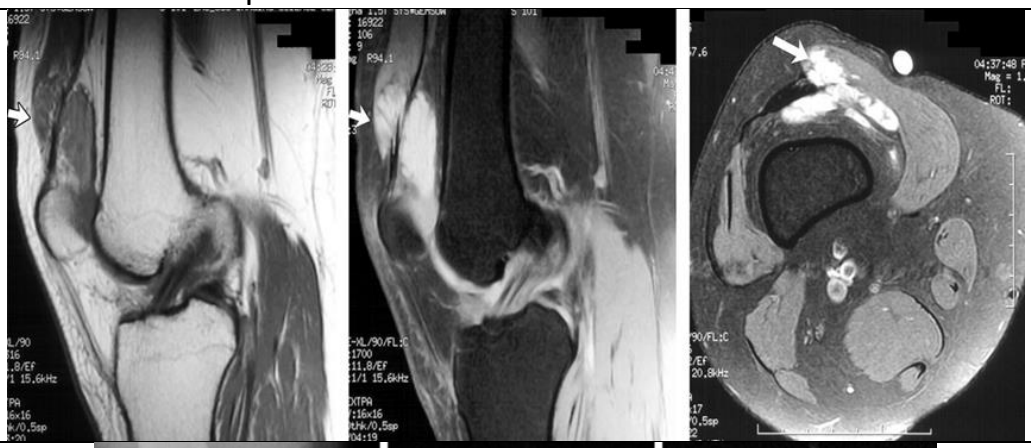


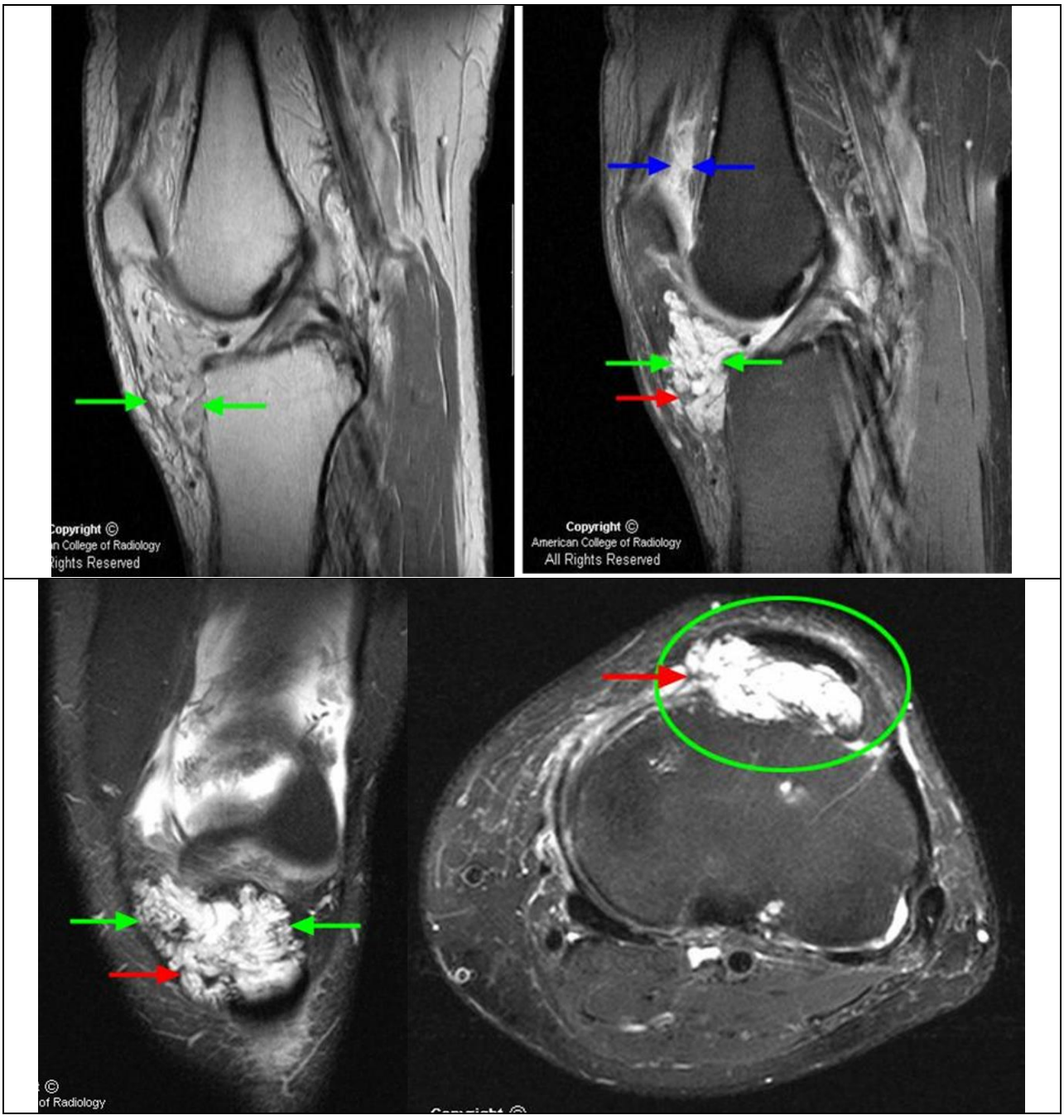
4) Synovial Hemangioma

- Synovial hemangioma is a rare benign vascular malformation
- Children and young adults
- Most common site: knee.
- Patients usually present with joint pain, swelling, and spontaneous hemarthrosis.

Imaging Findings:

- Lobulated intraarticular mass with characteristic SI:
- T1 WI: Intermediate SI
- T2 WI: Marked hyperintensity
- Low SI linear structures seen throughout the lesion on T2 WI are believed to represent fibrous septa or vascular channels

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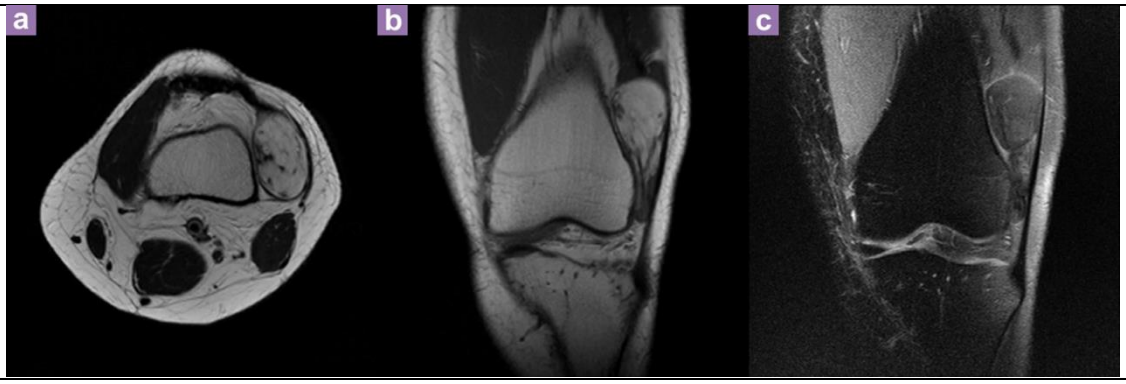
5) Klippel-Trenaunay-Weber Syndrome

6) Synoial Chondrolipoma



7) Synovial Sarcoma

- Synovial sarcoma is a mesenchymal neoplasm
- 10% of all primary soft-tissue malignant tumors
- The most common soft-tissue sarcoma to demonstrate radiographic mineralization and the one often radiologically confused with an extraskeletal osseous or cartilaginous tumor.

Location:

- Most common site: LL; particularly around the knee.
- Despite its name, synovial sarcoma does not arise from the synovial membrane but rather from primitive mesenchymal cells in the ***extraarticular*** soft tissues.

8) Synovial Chondrosarcoma

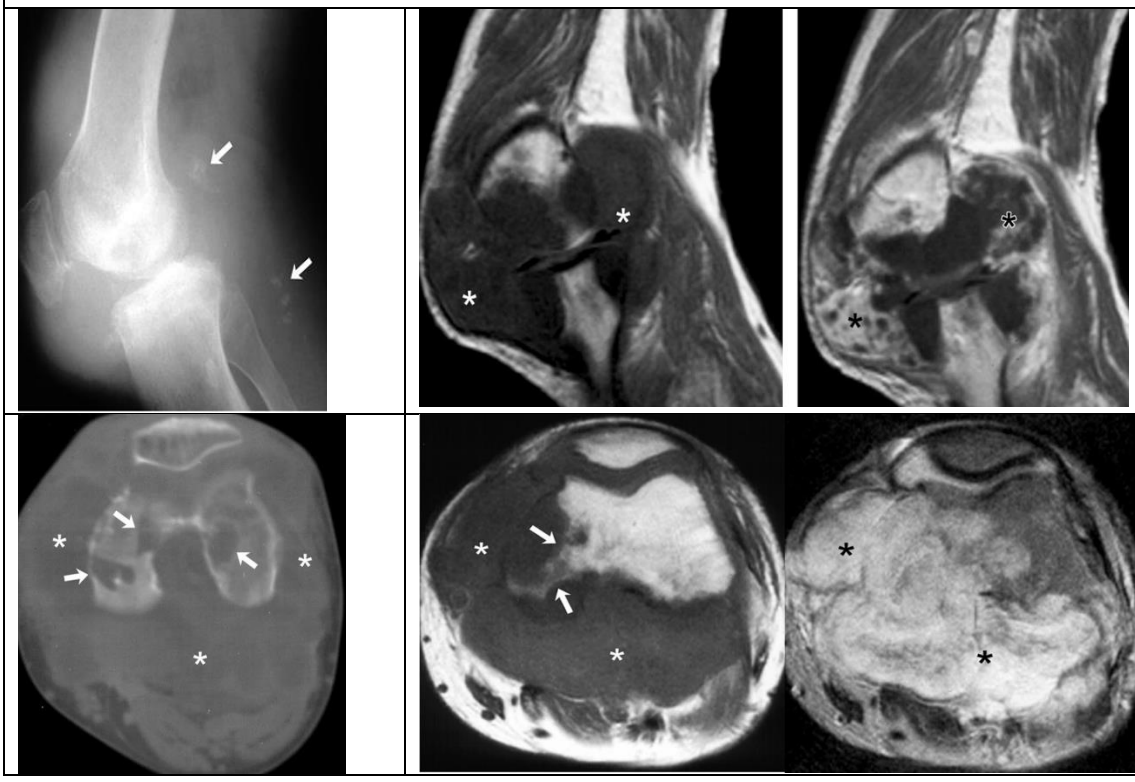
- Synovial chondrosarcoma is extremely rare.
- It is not clear whether it arises de novo or from malignant degeneration of synovial osteochondromatosis.
- Like synovial osteochondromatosis, synovial chondrosarcoma is characterized by metaplastic transformation of the synovium with formation of multiple cartilaginous nodules that can calcify and ossify.
- Age: 4th and 7th decades of life
- Most common site: knee and hip.

Radiographic Findings:

- The radiologic differentiation of synovial chondrosarcoma from synovial osteochondromatosis is difficult.
- Conventional radiographs usually demonstrate an intraarticular soft-tissue mass, which may contain calcified bodies.

MRI:

- Intraarticular lobulated soft tissue mass
- T1 WI: isointense signal
- T2 WI: hyperintense signal
- When the associated cartilaginous nodules contain calcification, small areas of low signal intensity are observed with all pulse sequences.
- Bone erosions can be seen in both synovial osteochondromatosis and synovial chondrosarcoma



9) Synovial Metastases

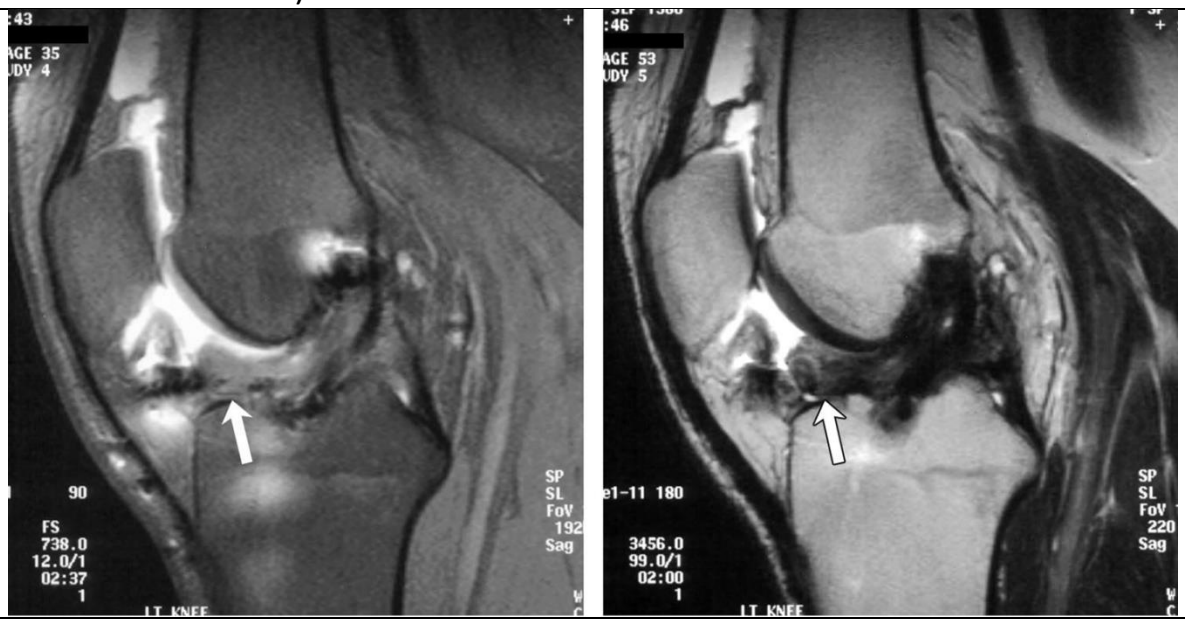
- The metastatic spread of tumors to the joints and synovium is rare
- Lung cancer is most common primary tumor.
- The knee is most commonly affected.
- Diagnosis can be made with either cytologic examination of the synovial fluid or synovial biopsy.
- Prognosis is generally poor, with an average survival of less than 5 months

10) Cyclops Lesion

- The cyclops lesion is named for its appearance on arthroscopy, as the globular scar tissue appears as a solitary eye.
- 1%–9.8% following anterior cruciate ligament reconstruction

MRI:

- Soft-tissue mass is seen anteriorly or anterolaterally in the intercondylar notch near the tibial insertion of the reconstructed ACL.
- T1 & T2: Intermediate to low signal intensity with all pulse sequences (due to its fibrous content)



DD for Multiple Intra-aticular Masses of Low T2 signal:

- **Synovial osteochondromatosis**
- **Pigmented villonodular synovitis (PVNS)**
- **Gout**
- **Amyloid arthropathy**
- **Hemochromatosis**
- **Hemophilic arthropathy**
- **Loose bodies.**
- **Rice bodies (RA, TB, Chronic synovitis, chronic bursitis)**
- **Metallosis.**

Metal-induced Synovitis

- Metallic wear debris generated by total knee replacement arthroplasty can lead to metal-induced synovitis.

- Curvilinear radiodense line outlining the synovial membrane of the capsule of the knee is noted, including the popliteal recess and the suprapatellar pouch.
- Dense joint fluid effusion

Intra-Articular Cystic Lesions

- **Synovial cyst**
- **Ganglion**
  - **Juxta-articular ganglion**
  - **Intra-articular ganglion**
  - **Periosteal ganglion**
- **Subchondral cyst (Geode)**
- **Meniscal cyst**
- **Bursa**

A- Synovial Cyst

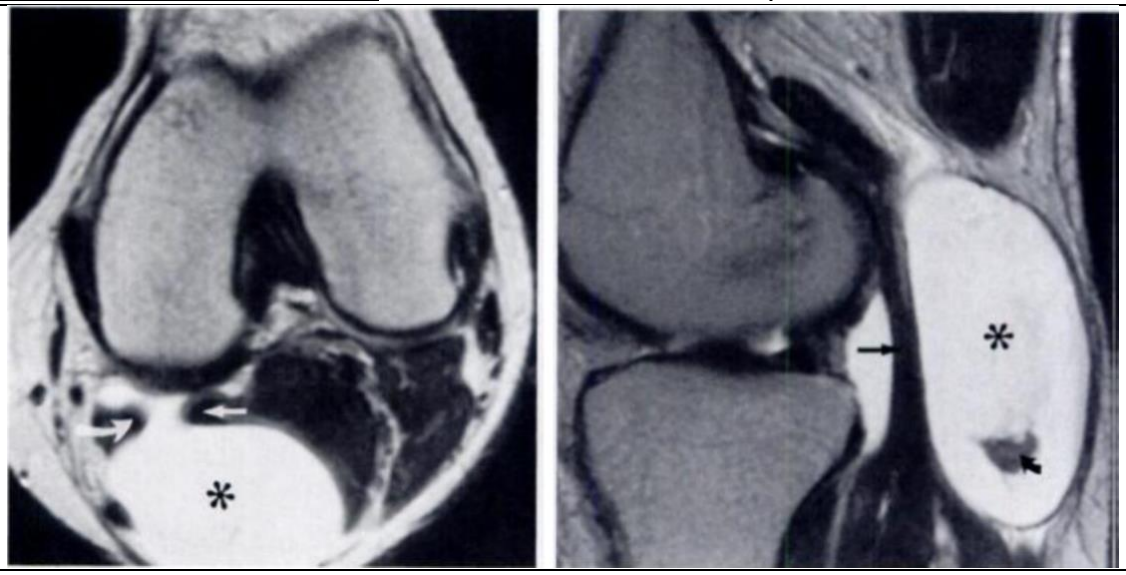
- is a juxta-articular fluid collection that is lined by synovial cells.
- A synovial cyst represents a focal extension of joint fluid that may, or may not, communicate with the joint, and may extend in any direction

❖ Baker Cysts (Popliteal Cyst):

- Fluid-filled distended synovial-lined lesions arising in the popliteal fossa between the medial head of the gastrocnemius and the semimembranosus tendons via a communication with the knee joint.
- They are usually located at or below the joint line.

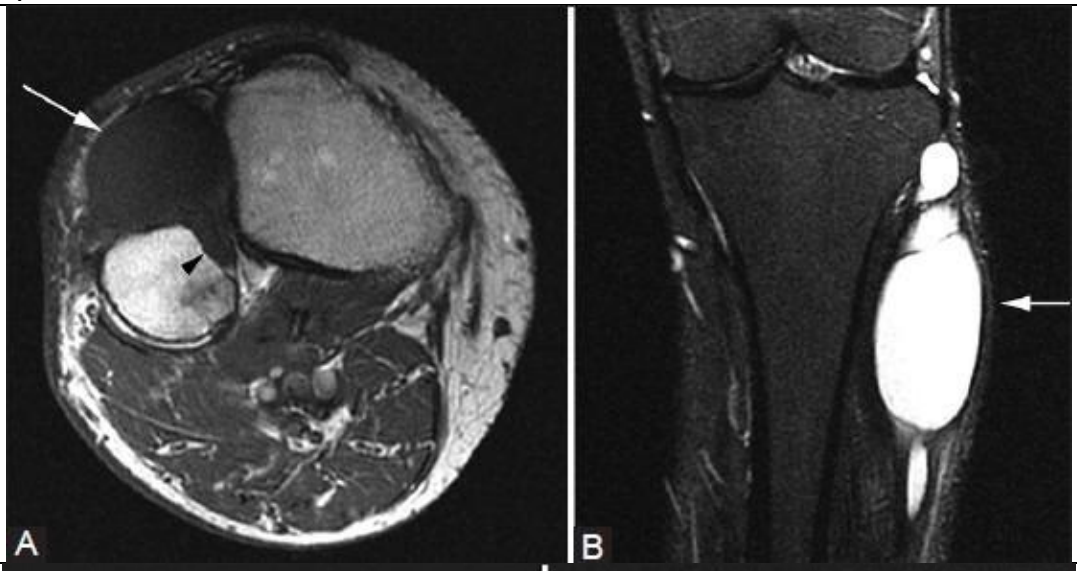
Complications

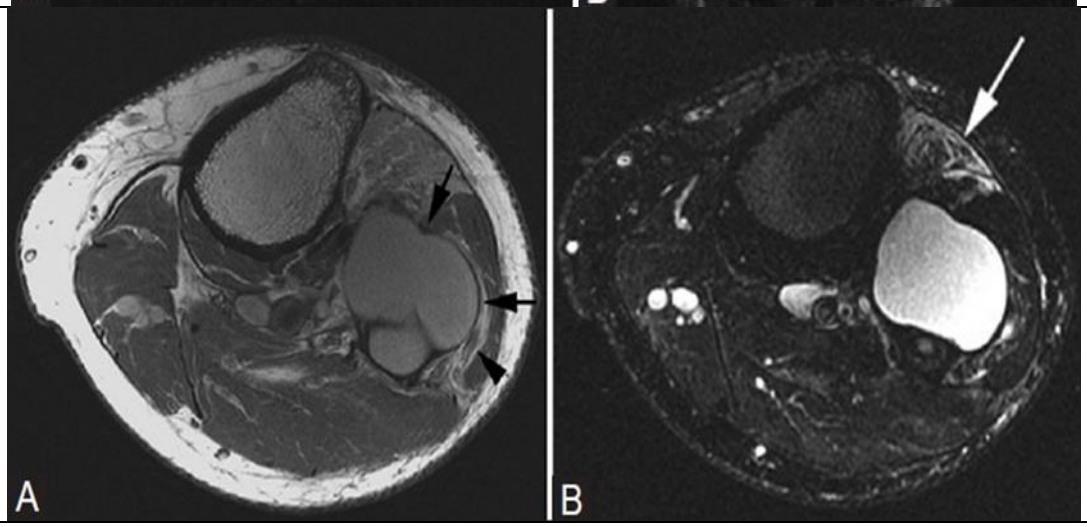
- **Dissection**: the cyst usually dissects inferomedially but can dissect proximally, anteriorly, intermuscularly or intramuscularly
- **Rupture:** leaking of cyst fluid into the popliteal fossa, between fascial planes and surrounding the hamstrings and medial gastrocnemius muscles; moreover, there is oedema of the soft tissue and irregularity of the cyst wall
- **Compression**: of the popliteal vessels and tibial nerve
- **Compartment syndrome:** can be either anterior or posterior



❖ Proximal Tibiofibular Joint PTFJ Cyst

- is a synovial joint that connects to the knee joint in 10% of patients
- It is hypothesized that increased knee joint pressure in these patients can result in the formation of a synovial cyst in the PTFJ.
- Large PTFJ cysts can compress the common peroneal nerve and result in foot drop and muscle weakness





B- Ganglion Cyst

- A cystic structure lined by flat spindle-shaped cells and contain mucin or fluid.
- Ganglia may arise from joint capsules, ligaments, tendon sheaths, bursae, or subchondral bone
- Not communicate directly with the joint

In relation to bone

- Within bone: intraosseous ganglion cyst
- Adjacent to bone : periosteal ganglion cyst
- Away from bone : soft tissue ganglion cyst

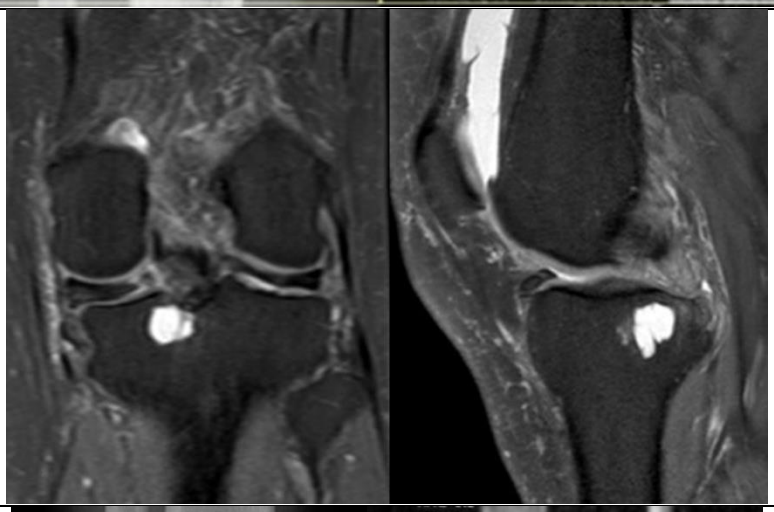
In relation to joint:

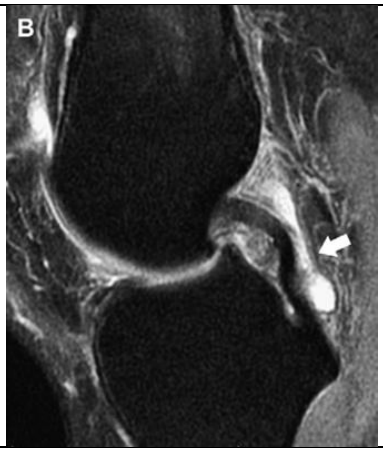
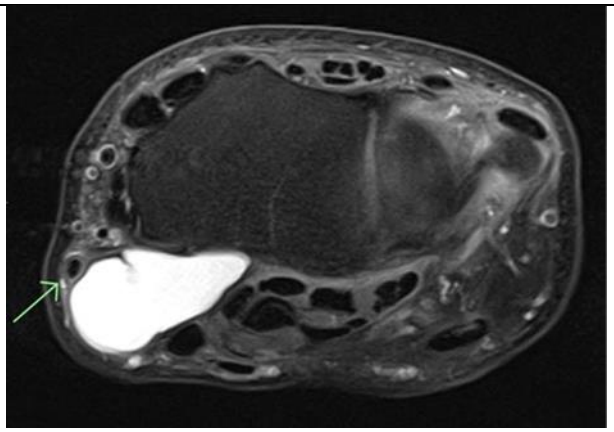
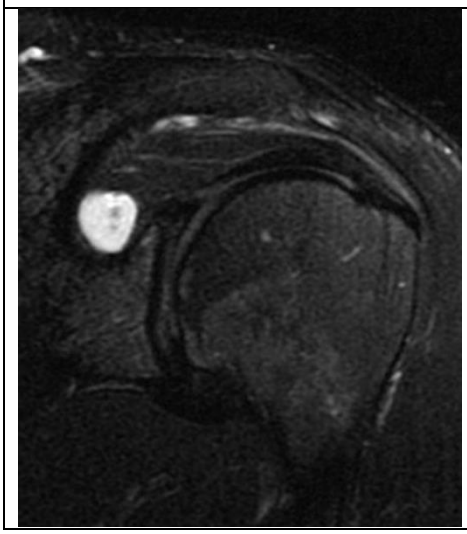
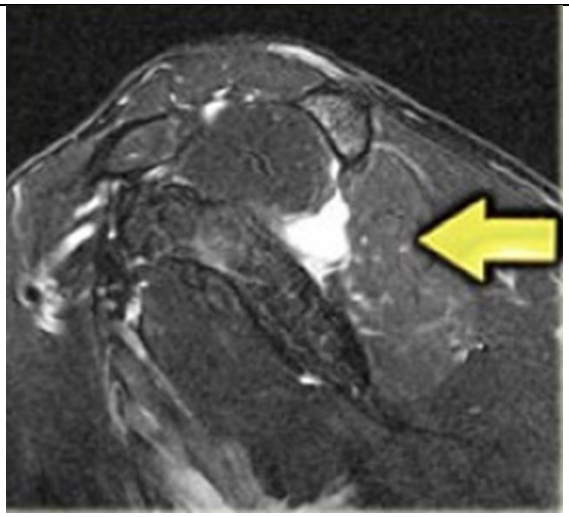
- Within the joint => intra-articular ganglion cyst
- Adjacent to a joint => juxta-articular ganglion cyst

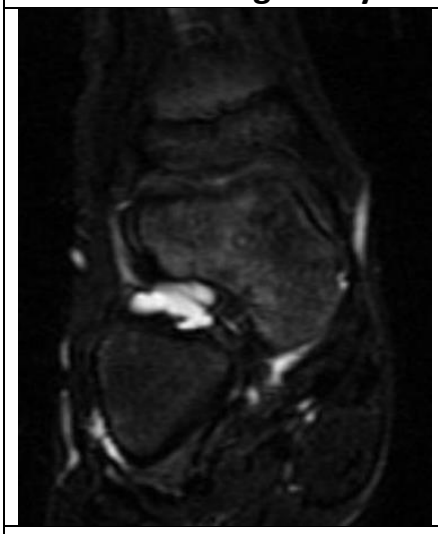
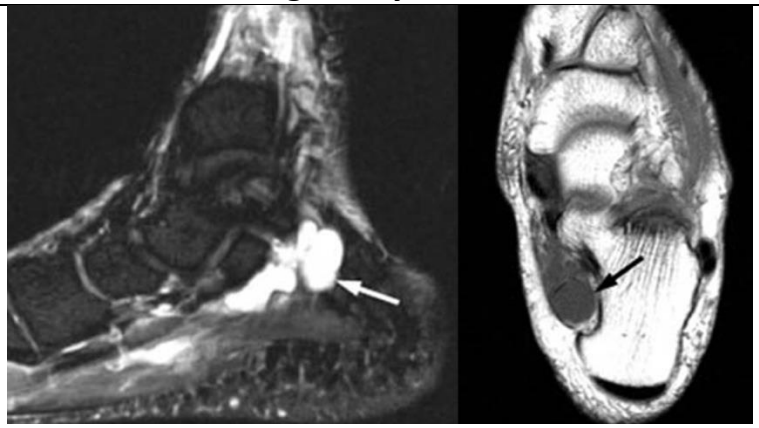
Imaging Findings:

- Cystic masses unilocular or multilocular
- Round to lobular in configuration
- Sharply defined internal septa
- Long-standing lesions often have a more complex appearance, especially if complicated by previous hemorrhage or infection
- +C: rim enhancement may be seen

❖ Intra-Osseous Ganglion Cyst



ACL Ganglion Cyst	PCL Ganglion Cyst
	
Wrist Ganglion Cyst	
	
Supraglenoid Notch Ganglion Cyst	**Spinoglenoid Ganglion Cyst**
	

Sinus Tarsi Ganglion Cyst	Tarsal Tunnel Ganglion Cyst
	

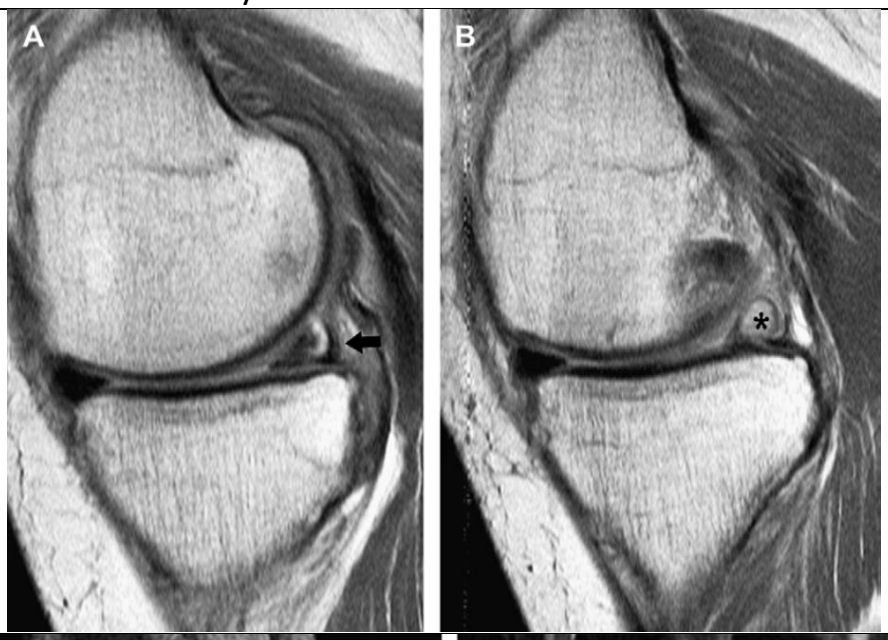
Peroneal Ganglion Cyst

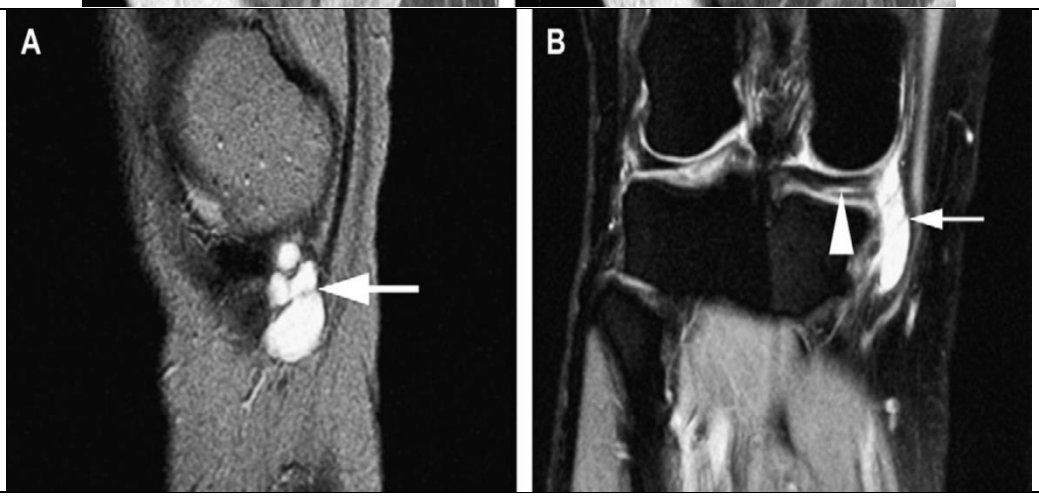
C- Meniscal Cyst

- A focal collection of synovial fluid located within, or adjacent to, the meniscus occurs due to synovial fluid getting encysted through a meniscal tear.
- When they extend beyond the bounds of the meninscus they are then termed parameniscal cysts.

Location:

- The cysts of medial meniscus usually are along the posterior aspect of posterior horn
- The cysts of Lateral meniscus are along the anterior / anterolateral aspect of the anterior horn or body





D- Bursa

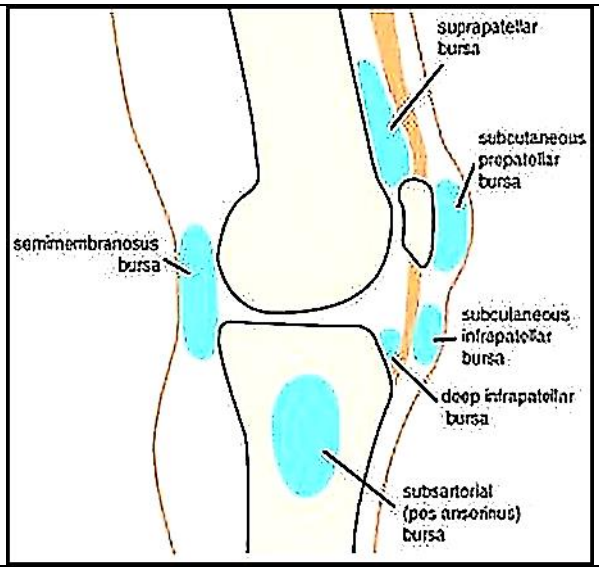
- Bursae are normally occurring, synovial-lined structures that function to reduce friction between moving structures, such as tendons, ligaments, and bone.
- Typically, they are not visible on imaging because they normally contain only limited fluid.
- Inflammation from local and systemic processes such as overuse, trauma, internal joint derangement, inflammatory arthropathy, and collagen vascular diseases, in addition to infection and hemorrhage, May cause thickening of the synovial lining and fluid accumulation

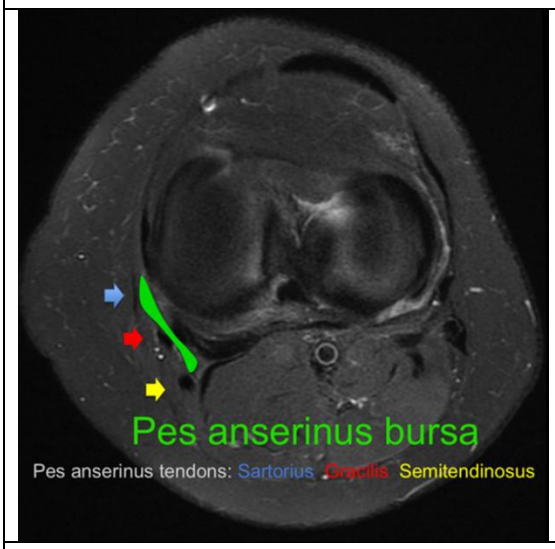
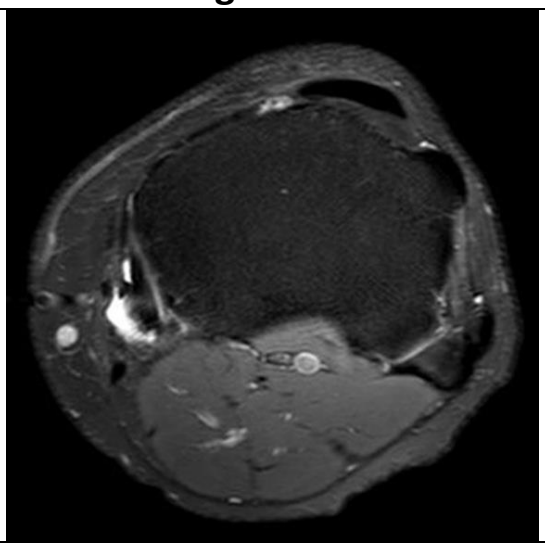
MR imaging of bursitis:

- increased fluid within the bursa
- Thickened bursal wall
- Surrounding tissue oedema
- Abnormal wall / surrounding tissue enhancement

Knee Bursae:

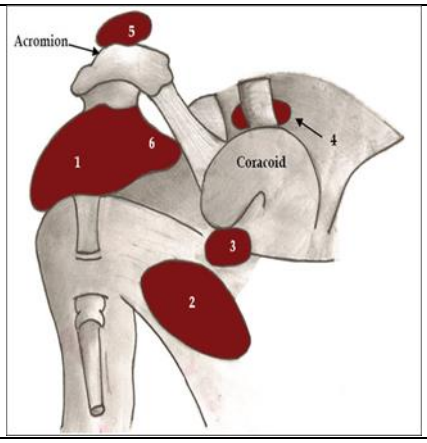
- Prepatellar
- Superficial infrapatellar, and deep infrapatellar bursae
- Pes anserine
- Iliotibial bursitis
- Medial (tibial) collateral ligament
- Fibular collateral ligament
- Semimembranosus-tibial collateral ligament bursae



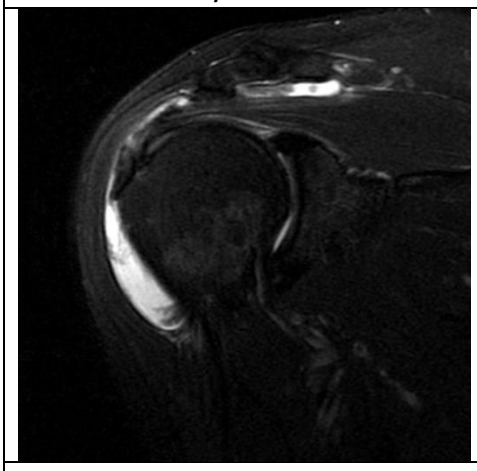
Pes anserinus Bursa	Semimembranosus-Tibial Collateral Ligament Bursa
	
Prepatellar Bursa	**Suprapatellar Bursa**
Superficial Infrapatellar Bursa	**Deep Infrapatellar Bursal Fluid**

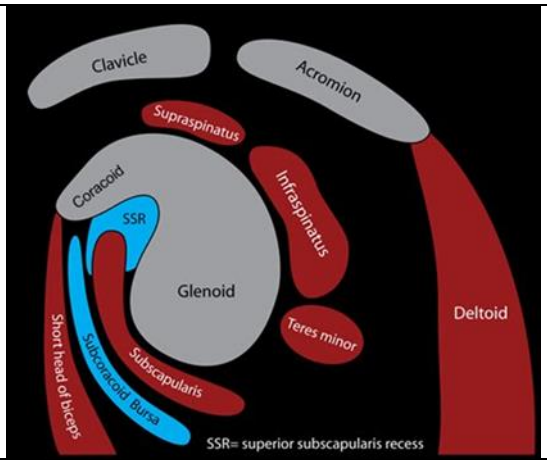
Shoulder Bursae:

1.Subacromial-subdeltoid bursa
2.Subscapular recess
3.Subcoracoid bursa
4.Coracoclavicular bursa
5.Supra-acromial bursa
6.Medial extension of SASD bursa

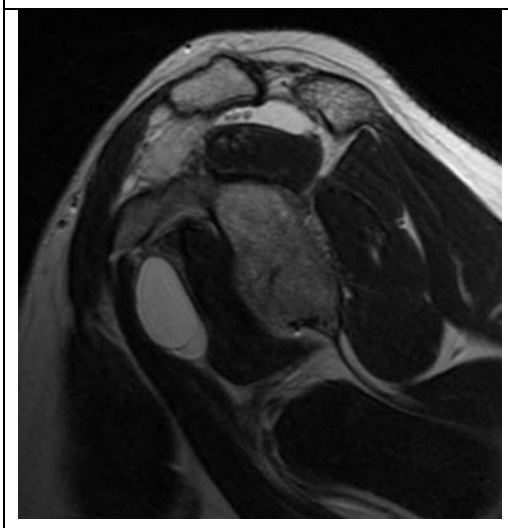


Subacromial / Subdeltoid Bursa

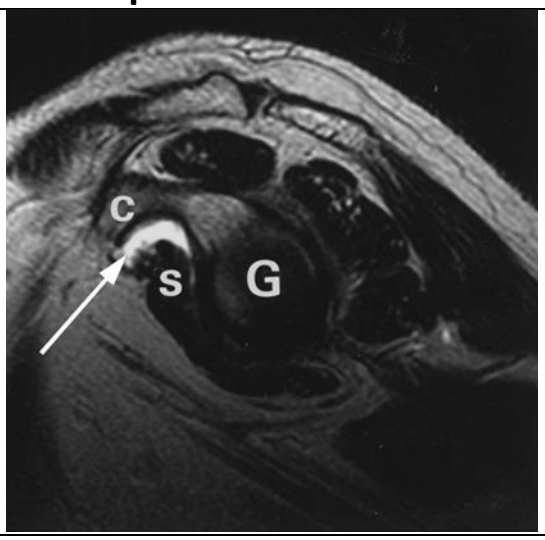




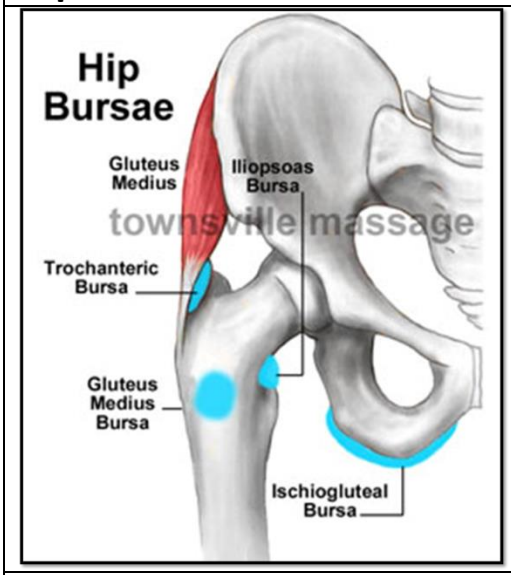
Subcoracoid Bursa



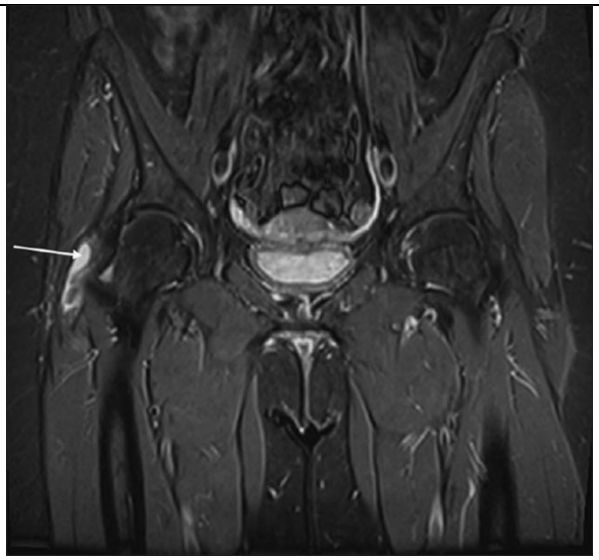
Subscapularis Bursa



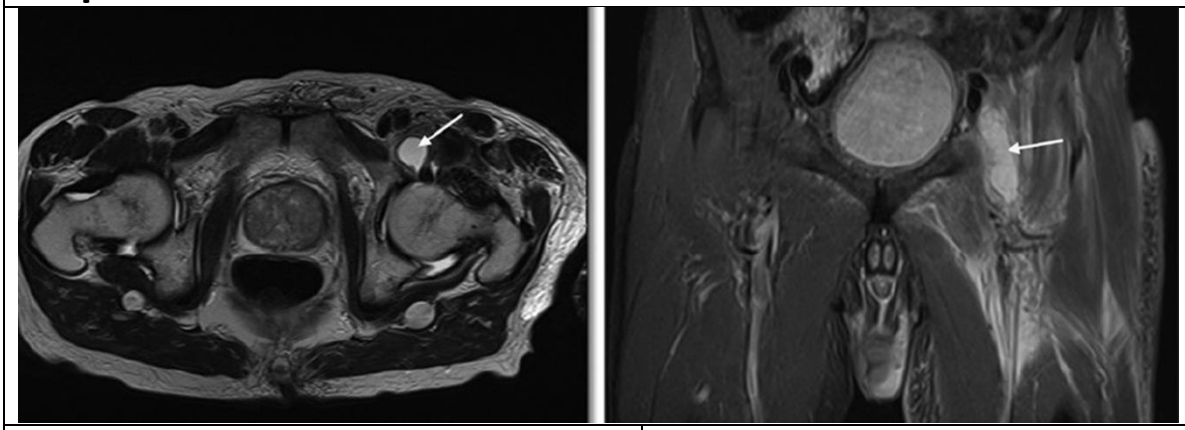
Hip Bursae



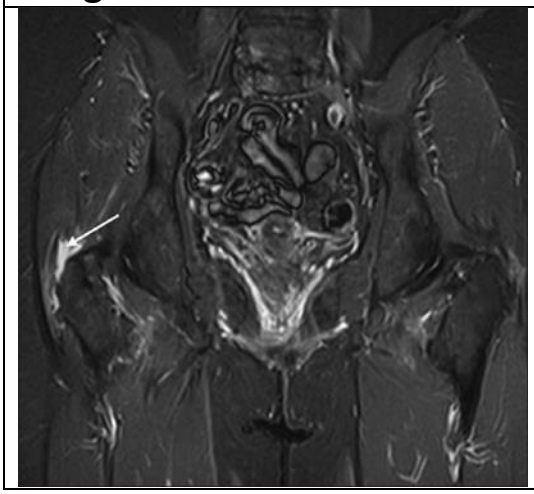
Greater Trochanteric Bursa



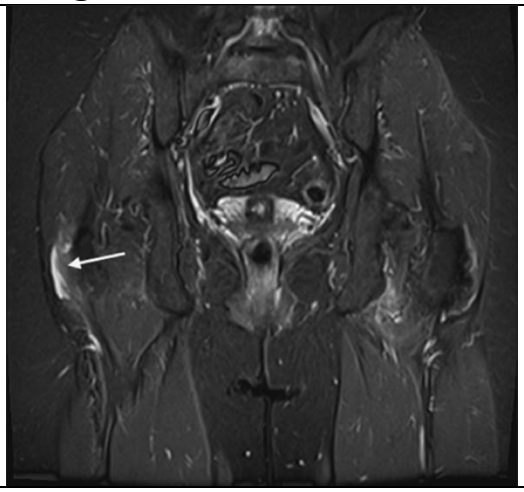
Iliopsoas bursa



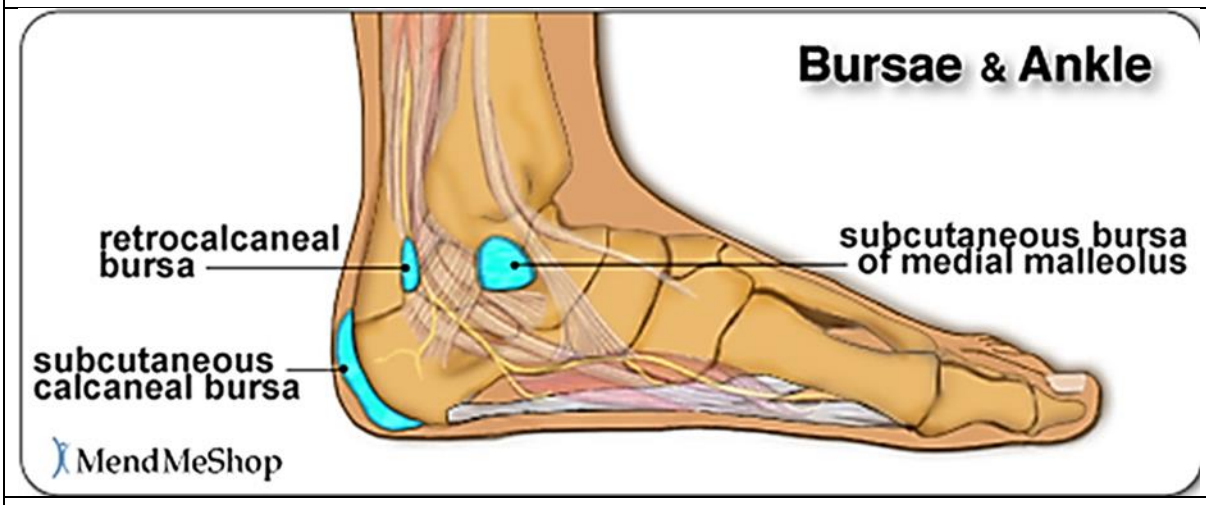
Subgluteus Minimus Bursitis



Subgluteus Medius Bursitis



❖ Ankle Bursae



Haglund Syndrome

- Bony enlargement at posterosuperior aspect of the calcaneus
- Bone marrow edema
- Soft tissue edema
- Achilles tendinopathy
- Retrocalcaneal bursitis
- Retro tendo-achilles bursitis